Annual report of the New Jersey State Agricultural Experiment ...

New Jersey Agricultural Experiment Stations

ELEVENTH ANNUAL REPORT

OF THE

NEW JERSEY STATE

Agricultural Experiment Station

AND THE

THIRD ANNUAL REPORT

OF THE

New Jersey Agricultural College Experiment Station

FOR THE YEAR

1890.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING COMPANY, PRINTERS.
1891.

To his Excellency Leon Abbett, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the eleventh annual report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10th, 1880, and which is chapter CVI. of the laws of that year.

ABRAHAM W. DURYEE,
President.

NEW BRUNSWICK, N. J., December 31st, 1890.

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OFFICERS OF THE STATION.

President MERRILL E. GATES, LL.D..Acting Director.
(Resigned October 1st, 1890.)
JAMES NEILSON, Esq..Acting Director.
(Appointed October 1st, 1890.)
EDWARD B. VOORHEES, A.M..Chemist.
LOUIS A. VOORHEES, A.M..Chemist.
JOHN P. STREET, B.S..Chemist.
CHARLES DIVINE, B.S., June 1st to November 30th................Chemist.
IRVING S. UPSON, A.M..Chief Clerk.

DAVID L. SCUDDER, until September 2d........Laboratory Attendant.
RICHARD TITUS, since September 8th............Janitor and Laboratory Attendant.

ORGANIZATION

OF THE

NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION.

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MERRILL E. GATES, PH D., LL.D, Acting Director. Resigned October 1st, 1890.

JAMES NEILSON, Esq., Acting Director. Appointed October 1st, 1890.

PROF. HORACE B. PATTON, PH.D., Chemical Geologist and Investigator of Soils. Resigned July 31st, 1890.

PROF. JULIUS NELSON, PH.D, Biologist and Investigator of Food-Products of State.

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PROF. PETER T. AUSTEN, F.C.S., Consulting Chemist.

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IRVING S. UPSON, A.M., Disbursing Clerk and Librarian.

J. LESTER RIGHTMIRE, Mailing Assistant.

JOHN THOMAS, Janitor and Laborer. Resigned September 30th, 1890.

TREASURER'S REPORT.

James Neilson, in account with the New Jersey Agricultural Experiment Station, January 1st, 1890, to January 1st, 1891:

RECEIPTS.

From State Treasurer	$10,827 20

PAYMENTS.

Salaries and pay of chemists and assistants	$6,495 66
Expenses of the Board of Managers	56 72
Stationery, including envelopes for Bulletins and Reports	391 89
Printing	1,230 22
Postage	131 80
Telephone and telegraph service	71 00
Fuel	252 16
Gas and water	251 82
Laboratory expenses	633 42
Field and feeding experiments	300 04
Freight, express and cartage bills	80 72
Expenses collecting samples of fertilizers	263 92
Traveling expenses	242 84
General fittings	375 99
Insurance	39 00
Annual dues, American Association Agricultural Colleges and Experiment Stations	10 00
	$10,827 20

Respectfully submitted,

JAMES NEILSON,
Treasurer.

The Auditing Committee of the Experiment Station have examined the accounts of the Treasurer of said Station and find them correct.

SAMUEL R. DEMAREST, Jr.,
D. D. DENISE,
Auditing Committee.

ELEVENTH ANNUAL REPORT.

The eleventh annual report of the New Jersey Agricultural Experiment Station, with the third report of the New Jersey State Agricultural College Experiment Station, is herewith presented. The policy of both Stations was planned by Dr. George H. Cook, after many years' experience and study of the needs of the State, and careful examination of the methods pursued by European stations, and has not been changed. The results of the work of the year have been mainly published in 13 bulletins, of which an increasing edition now of nearly 15,000 copies has been distributed to the farmers of the State. The ability and faithfulness of the staff of specialists have been recognized in a most gratifying manner by letters reporting the practical value of the bulletins and asking for their continuance.

The members of the staff keep in close contact with the farmers by visits to different parts of the State, and have given a large number of lectures and addresses before the State and County Boards of Agriculture and the horticultural societies and farmers' institutes. They have also carried on a large and growing correspondence with the farmers of the State.

The following bulletins have been published by the Stations during the year:

65. January 31st, 1890. Experiments with Different Breeds of Dairy Cows.
66. March 1st, 1890. Fertilizing Materials.
67. May 3d, 1890. Notes on the Wheat Louse.
68. April 30th, 1890. Experiments with Different Breeds of Dairy Cows.
69. July 15th, 1890. Analyses and Valuations of Complete Fertilizers.
70. July 26th, 1890. Some Fungous Diseases of the Spinach.
71. August 14th, 1890. Analyses of Incomplete Fertilizers; and the Value of Home Mixtures.

72. October 4th, 1890. Plant Lice, and How to Deal with Them.
73. October 6th, 1890. Analyses and Valuations of Complete Fertilizers.
74. October 21st, 1890. Ground Bones and Miscellaneous Samples.
75. November 7th, 1890. Insecticides, and How to Apply Them; Experiment Record for 1890.
76. November 28th, 1890. Some Fungous Diseases of the Sweet Potato.
77. December 11th, 1890. Experiments with Different Breeds of Dairy Cows.

Two special bulletins have also been published:

K. February 28th, 1890. The Insects Injuriously Affecting Cranberries.

L. April 22d, 1890. Observations upon the Peach for 1890.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION.

The working force of this Station is employed chiefly in the analyses of commercial fertilizers, and an investigation of their economical relations.

The analysis includes a sample of each brand sold in the State, now numbering over 250, besides such chemicals and miscellaneous materials as shall give sufficient data for a study of the relations that exist between unmixed goods, home mixtures, and manufactured brands. The further economical relations of fertilizers are studied through the means of field experiments. Fifteen of these were carried out this year on twelve farms in the different parts of the State, and included seven of the leading farm crops. Although these are conducted on different farms, they are Station experiments, and under the direct supervision of the Chemist of the Station. In every case he mixes the chemicals, lays out the plots, oversees the planting and harvesting, and selects the samples for analyses. The chief investigations made this year in new lines are of the potato. These were planned to test the effect of the different forms of potash, and the method of application of nitrogen as nitrate of soda upon the yield and quality of the product. Three experiments of 14 plots

each were carried out upon three farms differing radically in the character and previous treatment of the soil; from all of these plots an average sample was taken, which are now in process of complete chemical examination in the laboratory. An experiment looking toward a continued study of the sweet potato, a crop peculiarly adapted to a large section of the poorer sandy soils of the State, is also in progress. Four experiments to further test the adaptability of alfalfa to the different soils, and existing conditions of farming in the State, were also planned and carried through the year. With the exception of one experiment on peach trees, and on potatoes, the others are a continuation of those already in progress at the beginning of the season. The further analyses of such crops, fodders, feed, etc., as will aid in the direct study of economical rations, are also made from year to year.

The chemical work in connection with the study of dairy breeds, analyses of milk, fodder, feeds, etc., while provided for by the College Experiment Station, was under the direct supervision of the Chemist of the State Station, and who also prepared the bulletins for publication. It is, therefore, included in the report of the State Station. Inasmuch as the cattle were destroyed by the burning of the College Farm buildings on November 2d, complete records of the experiments are included in this report.

The efficient and faithful work of the Assistant Chemists in the laboratories, has contributed in no small measure to the successful accomplishment of the large amount of chemical work reported in the following pages.

NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION.

The work of the Station Botanist for the past year has been along the following lines:

(*a*) Experiments upon the cranberry bogs, with various substances, with a view of securing a remedy for the very destructive disease known as the "cranberry scald."

(*b*) Field experiments in various parts of the State upon sweet potatoes, to find, if possible, a preventive for the various kinds of decays, chiefly the so-called "soil rot" and "black rot."

(c) Experiments in spraying apple and pear orchards to check the ravages of the "scab" and "leaf blight" have been carried out, as also upon grapes, potatoes, celery and various other crops.

(d) The leading laboratory work has been an investigation into the nature of the several decays of sweet potatoes, upon which a bulletin has recently been published.

(e) The study of the fungous diseases of the spinach resulted in a bulletin issued in July.

(f) The troubles of the egg-plant, hot-house violets, and the raspberry—all serious during the past year—are now under consideration.

(g) Further work has been carried on with the study of the worst weeds of the State.

(h) A list of the botanists of the experiment stations, with an outline of the work in botany, has been prepared for the office of experiment stations.

The planned work of the Department of Entomology was in the systematic test of those insecticides that were on the market as such, and alse in the development of new agents of a destructive character. Particular attention was paid to the possibility of combining insecticide and fertilizer, and very gratifying results were reached.

A study of some species of plant lice which were unusually abundant, was made, and these were reported on.

A thorough study of the "rosebug" was made, and the facts as they bear upon the effect this insect may have on grape culture in New Jersey, were carefully investigated.

Field experiments were made on a large scale to test the value of recommendations made for the control of cranberry insects.

Four bulletins, together about 110 pages, have been prepared and published. It has been the object of the Entomologist to make his bulletins monographic in their nature, so that all the information can be easily gotten at. So, Bulletin K is confined to cranberry insects, and all that is known of cranberry insects is there given. Bulletin 72 is devoted to plant lice, and a general history of species and methods of dealing with them are given. Bulletin 75 is devoted entirely to insecticides and experiments made with them. The annual report contains a resumé of the work of the year and reports

on those insects studied which were not considered of sufficient importance to authorize monographic bulletins. The number of such species is large.

The Biologist has directed his attention mainly to a study of the principles that govern in successful oyster cultivation, with a view to the discovery and introduction among oyster-planters of more certain methods of propagation of this important shell-fish.

The methods now used in the propagation of food-fishes will, when we understand how best to apply them to oyster culture, result in very great practical benefits both to producers and consumers, in the increased oyster-supply, its improved quality, secured at less expenditure of labor, etc.

Several years seem necessary to cover the ground indicated above, and each year the reports of progress will be chapters in a continuous history.

The work the past summer, to mention but one line of investigation, has been devoted to experiments testing the conditions needful for the most successful impregnation of the egg of the oyster by the sperm-cells of the male oyster, in waters differing in degrees of saltness and of temperature.

Experiments have been carried on for the purpose of determining some of the differences in the physical conditions of heavy or clayey soils. A number of soils taken from the "Trap Rock," "Triassic Red Shale" and "Tertiary" areas have been separated into their mechanical constituents, and the relationship between coarseness of grain and fertility of soils discussed.

Experiments to determine the state of flocculation of soils show a great difference in this subject between the surface and subsoil, and also between the coarser and finer-grained soils.

The clerical work of the Stations, not only, but the printing, the accounts and the distribution of bulletins, have been thoroughly well done by the Chief Clerk and his assistants.

REPORT OF THE CHEMISTS.

REPORT OF THE CHEMISTS.

FERTILIZERS.

In this portion of its work the Station aims to publish all available information regarding the purchases, the sales and the uses of commercial fertilizers. The methods of securing this information remain unchanged year after year; the form of this report consequently remains unaltered.

This remark applies only to the kind of work done; its quantity is steadily increasing, and at present fully equals the capacity of this laboratory.

The subject is considered under the following divisions:

I.

FERTILIZER STATISTICS.

1. The quantity and value of the fertilizers used in New Jersey during the year 1890.
2. Comparison of this year's trade with that of the seven preceding years.

II.

THE COMMERCIAL RELATIONS OF FERTILIZERS.

1. Their market prices.
2. The sources of their nitrogen, phosphoric acid and potash, and their economical purchase and rational use.
3. Their guaranteed chemical composition and relative commercial value.

III.

AGRICULTURAL RELATIONS OF FERTILIZERS.

1. To test the effects of nitrate of soda, when used alone and in connection with the mineral elements, phosphoric acid and potash, upon the yield and maturity of tomatoes.
2. To test the effect of the different commercial forms of potash salts, viz., muriate, sulphate and kainit, upon the yield and quality of potatoes.
3. To test the effect of the best forms of plant-food upon sweet potatoes grown on light, sandy soil.
4. To determine the value of nitrate of soda as a spring top-dressing for wheat and grass.

I.

FERTILIZER STATISTICS.

1. The quantity and value of the fertilizers used in New Jersey during the year 1890.

2. Comparison of this year's trade with that of preceding years.

These statistics were taken by manufacturers from their books in answer to requests made by this Station. The reports were in each case returned on printed forms, of which the following is a copy:

SALES OF COMMERCIAL FERTILIZERS.

The following is a correct statement of the number of tons of the several classes of Commercial Fertilizers sold in New Jersey by ——— ——— during the year ending November 1st, 1890:

Number of tons of Complete Manure.......................................
" " Ammoniated Superphosphate without Potash, including Dissolved Bone, etc.......................
" " Ground Bone.......................................
" " Kainit.......................................
" " Muriate of Potash.......................................
" " Nitrogenous Matter.......................................
(a) Ammonium Sulphate.......................................
(b) Sodium Nitrate.......................................
(c) Blood, Ammonite, etc.......................................
Number of tons of Plain Superphosphates, including both Dissolved Bone Black and S. C. Acid Phosphate.........

The above circular was mailed to 60 firms, 45 of which, including those that have the largest sales in this State, forwarded itemized statements. These indicate a total consumption for this year in New Jersey of 39,516 tons, divided as follows:

1.

THE QUANTITY AND VALUE OF THE FERTILIZERS USED IN NEW JERSEY DURING THE YEAR 1890.

	Tons reported as sold in New Jersey.	Average retail price per ton.	Total value.
Complete Manure	27,236	$34 64	$943,455
Dissolved Bones, etc.	998	32 00	31,936
Ground Bone	1,679	32 74	54,971
Kainit	567	12 33	6,991
Muriate of Potash	393	41 75	16,408
Ammonite, Dried Blood, etc	1,314	31 84	41,838
Ammonium Sulphate	97	68 63	6,657
Sodium Nitrate	133	44 83	5,962
Bone-Black Superphosphate	4,925	22 00	108,350
S. C. Rock Phosphate	2,174	14 00	30,436
Total number of tons and value	39,516	....	$1,247,004

It is admitted that these statistics are incomplete, as they represent 45 manufacturers only of the 60 whose brands have this year been sampled in this State and analyzed by this Station.

As stated in previous annual reports, this statistical work is carried out without legal authority, the data being secured only through the courtesy of those manufacturers who, year after year, at their own expense, compile their reports in answer to direct requests.

The Inspectors who represent this Station report the retail prices of every brand sampled by them. These reports furnish the data from which the above average retail price for complete manures was obtained.

The average retail prices for kainit and all other products tabulated below it were furnished by manufacturers, consequently they do not include charges for freight, cartage, etc.

The complete manures represent 69 per cent. of the total number of tons sold last season, and 76 per cent. of the total value of all sales.

2.

COMPARISON OF THE YEAR'S TRADE WITH THAT OF PRECEDING YEARS.

The total sales of fertilizers reported this year is greater than for any preceding year since 1882, except 1884, when 10,000 tons of poudrette were included. The complete fertilizers, 27,236 tons, indicate an expenditure this year of about $950,000, or 76 per cent. of the total. This percentage is almost identical with that shown in previous years. In raw materials a decided increase is noticed only in the case of superphosphates.

Tonnage of Fertilizers Used in New Jersey.

	1882.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Number of tons of Complete Manure	15,941	21,894	22,424	24,498	22,500	25,413	23,864	27,236
" " Ammoniated Superphosphate without Potash (Dissolved Bone, etc.)	1,370	1,541	1,603	1,343	1,898	1,016	1,067	998
" " Ground Bones	2,509	3,172	2,237	2,338	2,465	2,036	1,498	1,679
" " Kainit	683	991	584	1,106	1,220	604	625	567
" " Muriate of Potash	144	291	331	255	314	449	491	393
" " Ammonite	719	783	250	*698	....	*1,703	†306	305
" " Ammonium Sulphate	76	54	55	21	95	53	95	97
" " Sodium Nitrate	26	40	17	24	93	157	205	133
" " Blood	244	1,581	263	....	411	....	....	....
" " Fish	228	228	....	....	184	....	1,184	1,009
" " Hair	248	574	434	723	363	....	677	....
" " Poudrette	3,450	10,200	6,000	5,000	....	....	....	....
" " Superphosphates, 30 to 40 per cent	562	....	....	....	....	....	....	....
" " Superphosphates, 11 to 18 per cent	3,963	5,315	....	....	....	....	....	....
" " Bone-Black Superphosphate	....	....	2,488	594	370	457	572	4,925
" " S. C. Rock	....	....	1,124	2,078	1,303	1,745	1,662	2,174
Total	30,163	46,664	37,810	38 678	31,216	33,633	32,246	39,516

*The total number of tons, in 1886 and 1888, under Ammonite, includes both blood and fish, returns having been made, in many cases, without discrimination.

†The total number of tons, in 1889, under Ammonite, includes blood.

The Average Retail Prices for 1882, 1884, 1885, 1886, 1887, 1888, 1889 and 1890.

	1882.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Complete Manure	$41 00	$38 00	$35 73	$36 68	$34 80	$34 83	$36 07	$34 64
Ammoniated Superphosphate without Potash (Dissolved Bone, etc)	32 00	31 00	31 62	29 25	32 63	31 90	31 83	32 00
Ground Bone	37 00	36 00	31 25	34 35	35 39	33 76	34 46	32 74
Kainit	12 00	10 00	11 75	10 60	10 25	12 83	12 10	12 33
Muriate of Potash	41 00	38 00	42 15	42 00	39 54	42 33	39 75	41 75
Ammonite	56 00	43 00	43 00	*40 40	....	*36 66	*34 60	31 84
Ammonium Sulphate	99 00	70 50	68 50	70 00	68 20	69 70	71 18	68 63
Sodium Nitrate	76 00	54 00	52 25	58 72	51 61	52 00	51 62	44 83
Blood	56 00	48 50	38 67	....	35 33	....	....	....
Fish	45 00	31 50	34 66	....	35 17	....	....	....
Hair	10 00	11 00	10 00	10 00	....	....	....	....
Poudrette	10 00	10 00	10 00	10 00	....	....	....	....
Superphosphates with 30 to 40 per cent. Phosphoric Acid	75 00	....	....	....	....	....	....	....
" " 11 " 18 " " " "	28 50	24 50	....	....	....	....	....	....
" made from Bone Black	34 00	26 00	29 86	25 85	26 95	24 80	24 55	22 00
" " " S. C. Rock	26 60	20 00	20 31	17 75	17 73	15 60	15 80	14 00

*The prices for blood, ammonite and fish have been averaged for the years 1886, 1888 and 1889, for reason mentioned above.

In raw materials, a very marked decrease is noticed in the prices of all the forms of nitrogen, and in bone black and South Carolina superphosphates. Potash from both kainit and muriate is slightly higher than in 1889. Ground bone is also lower than in any year except 1885, while the price of ammoniated superphosphates without potash is practically the same as in the three previous years. The effect of these lower prices of raw materials has been to reduce the price of complete fertilizers; the average price, $34.64 per ton, in 1890, is lower than in any previous tabulation.

The question has heen raised, whether the variations in the average prices of complete manures has been accompanied by corresponding variations in the absolute amounts of plant-food actually delivered to consumers. To answer this, the analyses made by the Station in past years have been averaged, with the following results:

	Total Nitrogen.	Total Phos. Acid.	Available Phos. Acid.	Insoluble Phos. Acid.	Potash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1890 average of 198 samples......	2.65	10.62	7.70	2.92	4.41
1889 " " 178 "	2.90	10.82	7.88	2.94	4.20
1888 " " 153 "	2.77	10.91	8.09	2.82	4.29
1887 " " 153 "	2.79	10.87	7.69	3.18	4.22
1886 " " 146 "	2.66	10.82	8.07	2.75	3.87
1885 " " 103 "	2.61	11.16	8.33	2.83	3.79

An examination of these figures indicates that no decided change in the average quality of fertilizers has occurred during the past six years. This is rendered more definite by computing cash valuations upon the basis of the Station's schedule for 1890.

On this basis, a fertilizer, to represent the average for each of the six years, would be valued as follows:

1890..........	$28 37	per ton.
1889..........	29 26	"
1888..........	29 20	"
1887..........	28 76	"
1886..........	28 24	"
1885..........	28 45	"

The decline in the prices of complete fertilizers from 1882 to 1890, therefore, was not accompanied by a corresponding decrease in the absolute amounts of plant-food delivered to consumers.

The total cash value of the reported sales of commercial fertilizers in this State during 1890, as compared with that of previous years, is as follows:

Total value of fertilizers reported for 1882	$1,070,113 00
" " " " " " 1884	1,369,604 00
" " " " " " 1885	1,116,670 00
" " " " " " 1886	1,181,266 00
" " " " " " 1887	1,022,434 00
" " " " " " 1888	1,125,881 00
" " " " " " 1889	1,106,223 00
" " " " " " 1890	1,247,004 00

II.

THE COMMERCIAL RELATIONS OF FERTILIZERS.

1. *Their market prices.*
2. *The sources of their nitrogen, phosphoric acid and potash, and their economical purchase and rational use.*
3. *Their guaranteed chemical composition and relative commercial values.*

1.

THE MARKET PRICES OF FERTILIZERS.

The preceding records show that the farmers of this State paid at least $943,000 last season for complete manures. It is therefore a matter of importance to ascertain the principal conditions which influence the selling prices of these materials.

Complete fertilizers are made by mixing a number of crude products, each of which contains one or more of the following elements of plant-food, viz.: Nitrogen, phosphoric acid and potash. Efforts have therefore been made to secure—

The average wholesale prices of nitrogen, phosphoric acid and potash.

The average retail prices of nitrogen, phosphoric acid and potash.

The advance in prices between the wholesale and retail markets.

The wholesale prices are quoted every Wednesday in the well-known trade journal, *The Oil, Paint and Drug Reporter.* These prices have been tabulated for the entire year, and have then been recalculated in order to express the results in the form adopted by the experiment stations of this country.

The retail prices were calculated from the analyses of those samples of raw materials published in this report, which were taken from goods in the hands of farmers and which had been bought for cash direct from the manufacturers of complete fertilizers.

A comparison of the retail and wholesale prices, secured as above described, gives the following:

	AVERAGE PERCENTAGES BY WHICH THE RETAIL PRICES EXCEED THE WHOLESALE.		
	1888.	1889.	1890.
Nitrogen from Nitrate of Soda	22.5	22.1	25.8
" " Sulphate of Ammonia	7.6	9.5	5.0
" " Dried Blood	6.0	....	....
" " Dried Fish	....	....	....
" " Ammonite	11.6	6.0	....
Soluble Phosphoric Acid from Bone Black	....	....	....
" " " " S. C. Rock	33.3	48.8	43.6
Reverted " " " Bone Black	....	....	....
" " " " S. C. Rock	33.3	48.8	43.6
Insoluble " " " Bone Black	....	....	....
" " " " S. C. Rock	33.3	....	....
Potash from High-Grade Sulphate	....	16.7	17.0
" " Double Sulphate of Potash and Magnesia	35.5	27.7	....
" " Kainit	34.2	14.3	19.0
" " Muriate	11.1	5.4	13.5
" " Sylvinit	....	....	35.0

A summary of these averages for five years shows that the wide difference between wholesale and retail prices of available phosphoric acid, noticed in 1889, has been only slightly reduced in 1890. In the case of nitrogen the difference has been increased by three per cent., and in potash salts it is practically identical with last year.

SUMMARY.

Retail Prices Exceed Wholesale by the Following Percentages.

	1886.	1887.	1888.	1889.	1890.
Nitrogen	25.4	19.7	11.9	12.5	15.4
Available Phosphoric Acid	35.0	33.0	33.3	48.8	43.6
Potash	36.2	29.0	26.9	16.0	16.5

The data upon which all of the above information depends will be found on the following pages.

THE WHOLESALE PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH IN CRUDE PRODUCTS.

The table showing the wholesale prices of crude products, as taken from *The Oil, Paint and Drug Reporter*, follows on the next page. From it the table of wholesale prices of actual plant-food have been calculated upon the basis of the following average analyses:

Nitrate of Soda	16	per cent Nitrogen.
Sulphate of Ammonia	20½	" " "
Dried Blood and Ammonite	12½	" " "
Acid Phosphate	12	" " Available Phosphoric Acid.
High-Grade Sulphate of Potash	50	" " Potash.
Double Sulphate of Potash and Magnesia,	25	" " "
Muriate of Potash	50	" " "
Kainit	12½	" " "
Sylvinit	15	" " "

Nitrogen, Phosphoric Acid and Potash—Wholesale Prices in New York, Per Ton.

MONTHS.	OF NITROGENOUS MATTER.								ACID PHOSPHATE.		OF POTASH SALTS.									
	NITRATE OF SODA.		SULPHATE OF AMMONIA.		AZOTINE.		DRIED BLOOD.				MURIATE OF POTASH.		KAINIT.		SYLVINIT.		DOUBLE SULPHATE OF POTASH AND MAGNESIA.		HIGH-GRADE SULPHATE.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	$38.60	$37.60	$64.00	$62.50	$32.25	$30.60	$30.15	$29.09	$9.90	$9.60	$37.50	$36.00	$11.00	$10.40	$13.74	$13.07	$24.00	$23.00	$50.50	$50.00
February	38.10	36.60	64.00	62.50	31.82	30.80	29.55	28.78	9.90	9.60	37.50	36.00	11.00	10.50	14.07	13.07	24.00	23.00	50.50	50.00
March	38.00	36.00	64.00	62.50	31.06	29.55	29.55	28.78	9.90	9.60	37.50	36.00	11.00	10.50	14.07	13.07	24.00	23.00	49.75	49.00
April	35.70	34.80	64.00	62.50	31.06	29.55	29.55	28.18	9.90	9.60	37.50	36.00	11.00	10.90	14.07	13.74	24.00	22.60	49.00	47.60
May	36.00	34.10	64.00	61.85	31.06	29.55	28.41	27.65	9.90	9.86	37.50	35.60	11.00	10.81	14.07	14.07	24.00	22.50	49.00	47.50
June	36.00	34.10	67.00	63.00	31.06	28.78	28.78	27.65	9.90	9.80	37.50	35.50	11.00	9.56	14.07	14.07	24.00	22.50	49.00	47.50
July	35.60	33.70	70.00	67.00	30.76	28.78	28.64	27.88	9.18	8.82	37.50	35.50	11.00	9.75	14.07	13.07	24.00	22.50	49.00	47.50
August	35.00	33.50	70.00	66.60	29.16	28.22	27.65	26.70	9.00	8.70	37.50	35.50	11.00	9.75	13.40	12.78	24.00	22.50	49.00	47.50
September	35.10	34.10	70.00	66.80	28.78	27.27	27.27	25.77	9.00	8.70	37.50	35.50	11.00	9.75	13.07	12.40	24.00	22.50	49.00	47.50
October	36.70	35.80	70.00	66.00	29.70	28.94	27.27	26.06	9.00	8.70	37.50	35.50	11.00	9.75	13.07	12.40	23.60	22.50	42.60	41.90
November	37.60	35.75	70.00	66.00	28.78	28.08	27.27	26.33	9.00	8.70	36.75	35.00	11.00	9.75	13.07	12.40	23.00	22.40	41.85	40.75
December	37.00	34.60	70.00	66.00	28.78	28.08	27.27	26.52	9.00	8.70	37.00	35.50	10.60	9.55	13.07	12.40	23.00	22.50	42.50	41.50

Wholesale Prices in New York, Per Pound, of Plant-Food.

MONTHS.	Wholesale cost per pound of nitrogen in form of— Nitrate of Soda. Max.	Nitrate of Soda. Min.	Sulphate of Ammonia. Max.	Sulphate of Ammonia. Min.	Azotine. Max.	Azotine. Min.	Dried Blood. Max.	Dried Blood. Min.	Wholesale cost ℔ ℔. of phosphoric acid in form of— Acid Phosphate. Max.	Acid Phosphate. Min.	Wholesale cost per pound of potash in form of— Muriate of Potash. Max.	Muriate of Potash. Min.	Kainit. Max.	Kainit. Min.	Sylvinit. Max.	Sylvinit. Min.	Double Sulphate of Potash and Magnesia. Max.	Double Sulphate of Potash and Magnesia. Min.	High-Grade Sulphate. Max.	High-Grade Sulphate. Min.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
January	12.1	11.8	15.6	15.2	12.9	12.2	12.1	11.6	4.1	4.0	3.8	3.6	4.4	4.2	4.1	3.9	4.8	4.6	5.1	5.0
February	11.9	11.4	15.6	15.2	12.7	12.1	11.8	11.5	4.1	4.0	3.8	3.6	4.4	4.2	4.2	3.9	4.8	4.6	5.1	5.0
March	11.9	11.3	15.6	15.2	12.4	11.8	11.8	11.5	4.1	4.0	3.8	3.6	4.4	4.2	4.2	3.9	4.8	4.6	5.0	4.9
April	11.2	10.7	15.6	15.2	12.4	11.8	11.8	11.3	4.1	4.0	3.8	3.6	4.4	4.4	4.2	4.1	4.8	4.5	4.9	4.8
May	11.3	10.7	15.6	15.1	12.4	11.8	11.4	11.1	4.1	3.9	3.8	3.6	4.4	4.1	4.2	4.2	4.8	4.5	4.9	4.8
June	11.3	10.7	16.3	15.4	12.4	11.5	11.5	11.1	4.1	3.9	3.8	3.6	4.4	3.8	4.2	4.2	4.8	4.5	4.9	4.8
July	11.1	10.5	17.1	16.8	12.3	11.5	11.5	11.2	3.8	3.7	3.8	3.6	4.4	3.9	4.2	3.9	4.8	4.5	4.9	4.8
August	11.0	10.5	17.1	16.2	11.6	11.3	11.1	10.7	3.8	3.6	3.8	3.6	4.4	3.9	4.0	3.8	4.8	4.5	4.9	4.8
September	11.0	10.7	17.1	16.2	11.5	10.9	10.9	10.3	3.8	3.6	3.8	3.6	4.4	3.9	3.9	3.7	4.8	4.5	4.9	4.8
October	11.5	11.2	17.1	16.1	11.9	11.6	10.9	10.4	3.8	3.6	3.8	3.6	4.4	3.9	3.9	3.7	4.7	4.5	4.8	4.2
November	11.6	11.2	17.1	16.1	11.5	11.2	10.9	10.5	3.8	3.6	3.7	3.5	4.4	3.9	3.9	3.7	4.6	4.5	4.1	4.1
December	11.6	10.8	17.1	16.1	11.5	11.2	10.9	10.6	3.8	3.6	3.7	3.6	4.2	3.8	3.9	3.7	4.6	4.5	4.3	4.2
Average for 1890	11.3		16.1		11.9		11.2		3.9		3.7		4.2		4.0		4.6		4.7	
Average for 1889	13.1		15.7		14.9		14.5		4.1		3.7		4.2		....		4.7		4.8	
Average for 1888	13.3		15.8		13.8		13.6		....		3.6		3.8		....		4.5		....	

With the exception of sulphate of ammonia, which steadily increased in price throughout the year, all raw materials were lower in December than in January. Nitrate of soda touched the lowest point —$35 per ton—in August, after which time there was a steady increase, closing in December at $37. The prices of organic nitrogen and acid phosphate did not fluctuate, being highest in January and lowest in December, a decline of about 10 per cent. for the year. With the exception of high-grade sulphate, which dropped from $49 per ton in September to $42.60 per ton in October, the prices of potash salts ruled quite uniform throughout the year, though all were slightly lower in December than in January. The average prices of nitrogen in nitrate of soda, dried blood and azotine in 1890 are considerably lower than in 1889. The average of phosphoric acid is also lower, while potash rules practically the same.

AVERAGE RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH IN CRUDE PRODUCTS.

With few exceptions, the samples of raw materials published in this report were taken from goods in the hands of farmers and had been bought for cash direct from the manufacturers of complete fertilizers. After an analysis of the samples, therefore, it was not difficult to calculate the retail prices per pound of the various forms of nitrogen, phosphoric acid and potash used in this trade.

The tables in subsequent pages furnish in detail the information gained by this work, and afford data also for the following summary. For comparison, results secured in a similar manner in 1886, 1887, 1888, 1889 and 1890 are republished:

	1886.	1887.	1888.	1889.	1890.
	cts	cts.	cts.	cts.	cts.
Cost per pound of Nitrogen from Nitrate of Soda	18.2	16.0	16.3	16.0	14.2
" " " " " " Sulphate of Ammonia	18.1	16.5	17.0	17.2	16.9
" " " " " " Dried Blood	20.0	16.4	14.4	20.0	16.0
" " " " " " Dried Fish	*16.6	15.2	15.3	14.9	14.1
" " " " " " Ammonite	....	15.2	15.4	....	....
" " " " Soluble Phosphoric Acid from Bone Black	7.8	8.2	7.5	7.4	6.7
" " " " " " " " S. C. Rock	7.4	7.5	6.2	6.1	5.6
" " " " Reverted " " " Bone Black	7.8	8.2	7.5	7.4	6.7
" " " " " " " " S. C. Rock	7.4	7.5	6.2	6.1	5.6
" " " " Insoluble " " " Bone Black	1.9	2.0	1.9	1.8	1.7
" " " " " " " " S. C. Rock	1.9	1.9	1.5	1.5	1.4
" " " " Potash from High-Grade Sulphate	5.8	5.7	4.7	5.6	5.5
" " " " " " Double Sulph. Potash & Magn'a,	6.5	6.2	6.1	6.0	....
" " " " " " Kainit	4.2	4.0	5.1	4.8	5.0
" " " " " " Muriate	4.0	4.1	4.0	3.9	4.2
" " " " " " Sylvinit	....	....	....	....	5.4

*This average also represents the retail cost of nitrogen in ammonite and castor pomace.

These averages are the *manufacturers' retail cash prices for the nitrogen, phosphoric acid and potash in the crude stock from which complete fertilizers are made.*

COMPARISON BETWEEN THE AVERAGE WHOLESALE AND RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH.

The conclusions reached in regard to the wholesale and retail prices are here tabulated. They represent the manufacturers' *wholesale* and *retail* prices for plant-food *in its best forms.* The percentages by which the retail prices exceed the wholesale have been taken as the basis of the comparison :

	MANUFACTURERS' AVERAGES.				AVERAGE PERCENTAGE BY WHICH THE RETAIL PRICES EXCEED THE WHOLESALE.		
	Wholesale prices for 1889.	Retail prices for 1889.	Wholesale prices for 1890.	Retail prices for 1890.	1888.	1889.	1890.
	cts.	cts.	cts.	cts.			
Nitrogen from Nitrate of Soda	13.1	16.0	11.3	14.2	22.5	22.1	25.8
" " Sulphate of Ammonia	15.7	17.2	16.1	16.9	7.6	9.5	5.0
" " Dried Blood	14.5	20.0	11.2	16.0	6.0	37.9	42.9
" " " Fish	....	14.9	....	14.1	....	....	....
" " Ammonite	....	....	....	....	11.6	....	....
Soluble Phosphoric Acid from Bone Black	....	7.4	....	6.7	....	....	....
" " " " S. C. Rock	4.1	6.1	3.9	5.6	33.3	48.8	43.6
Reverted " " " Bone Black	....	7.4	....	6.7	....	....	....
" " " " S. C. Rock	4.1	6.1	3.9	5.6	33.3	48.8	43.6
Insoluble " " " Bone Black	....	1.8	....	1.7	....	....	....
" " " " S. C. Rock	....	1.5	....	1.4	33.3	....	....
Potash from High-Grade Sulphate	4.8	5.6	4.7	5.5	....	16.7	17.0
" " Double Sulphate of Potash and Magnesia	4.7	6.0	4.6	....	85.5	27.7	....
" " Kainit	4.2	4.8	4.2	5.0	34.2	14.3	19.0
" " Muriate	3.7	3.9	3.7	4.2	11.1	5.4	18 5
" " Sylvinit	....	....	4.0	5.4	....	....	35.0

2.

THE SOURCES OF NITROGEN, PHOSPHORIC ACID AND POTASH.

To consumers of commercial fertilizers, a knowledge of the kind and the average composition of unmixed fertilizing materials is important, and the frequent inquiries from farmers indicate a desire for detailed information on these points. Such information is therefore presented in the following table:

Table Showing the Principal Fertilizing Materials, and the Average Amount in Each of Nitrogen, Phosphoric Acid or Potash.

KIND OF MATERIAL.		CONTAINING POUNDS PER HUNDRED OF— Nitrogen.	Phosphoric Acid Available.	Phosphoric Acid Insoluble in Water.	Actual Potash.
Nitrogen	Nitrate of Soda	16.0	....	....	....
	Sulphate of Ammonia	20.0	....	....	....
	Dried Blood, High Grade	14.0	....	....	....
	Ammonite, " "	12.0	....	3.0	....
Phosphoric Acid	Bone-Black Superphosphate	....	16.0	....	....
	S. C. Rock Superphosphate	....	12.0	3.0	....
Potash	Muriate of Potash	....	....	....	50.0
	High-Grade Sulphate	....	....	....	50.0
	Double Sulphate	....	....	....	26.0
	Kainit	....	....	....	12.5
	Sylvinit	....	....	....	15.0
Nitrogen, Phosphoric Acid and Potash	Ground Bones	3.5	....	20.0	....
	Dissolved Bones	1.5	12.0	3.0	....
	Dried Fish	7.0	....	7.0	....
	Tankage	7.0	....	10.0	....
	Cotton-Seed Meal	7.0	....	3.0	2.0
	Castor Pomace	6.0	....	2.0	1.0

THE ECONOMICAL PURCHASE AND RATIONAL USE OF NITROGEN, PHOSPHORIC ACID AND POTASH.

The materials containing but one element in readily available forms and in definite amounts are termed standard, and are divided into distinct classes, furnishing—1. Nitrogen; 2. Phosphoric Acid; 3. Potash; while those furnishing two or more elements, which vary in composition and availability between reasonably narrow limits, are grouped under another head.

Other materials, largely waste products, are on the market, and

have a recognized value, but are not sufficiently uniform in composition to be included in the classification.

The above table shows, first, that fertilizing materials furnish nitrogen, phosphoric acid and potash, and second, that they exist in the different materials in different forms and quantities. These actual elements have a definite commercial value, which varies from year to year as the conditions of the markets change.

It is evident, therefore, that the *direct value* to the farmer of *any fertilizing material is determined by the amount and kind of the actual fertilizing elements which it contains.*

The economical purchase of fertilizers from the commercial standpoint depends not only upon the high or low price paid per ton, but also upon *the relation which exists between the price per ton and the amount of the elements furnished, i. e.* upon the *cost per pound of the nitrogen, phosphoric acid and potash.*

This may be illustrated as follows: A. buys a fertilizer for $34 per ton, guaranteed to contain 4 per cent. nitrogen, 10 per cent. available phosphoric acid and 5 per cent. potash; while B. buys one for $30 per ton, guaranteed to contain 2 per cent. nitrogen, 8 per cent. phosphoric acid and 3 per cent. potash. Assuming that in both cases the materials used are secured from the best sources, in the case of A. the actual cost would be 17 cents per pound for nitrogen, 8 cents for phosphoric acid and 4½ cents for potash, while that of B. would furnish nitrogen at 22.6 cents, phosphoric acid at 10.6 cents and potash at 6 cents per pound.

In the case of the *higher cost per ton* the materials are furnished *33 per cent. cheaper* than in the lower cost per ton.

The buying of fertilizers is therefore virtually a buying of pounds of *nitrogen, phosphoric acid and potash.* In purchasing them in the form of concentrated unmixed materials a saving is effected in the actual cost and a definite knowledge of their quality is obtained.

While these points are important and should be observed by the careful and progressive farmer, there is in the consideration of this subject another point of equal and perhaps in many cases of still greater importance, viz., rational use. *Economical buying should be accompanied by rational use.*

Among the first questions that are asked by those farmers who are interested in this subject are:

1. *What is the best fertilizer for wheat, corn, oats, potatoes, etc.?* as the case may be; and

2. *How much shall I use per acre?* These are pertinent and practical questions, and it would seem to be the province of the Experiment Station to at least give such information as shall guide in their solution.

It should be remembered in this connection that *nitrogen, phosphoric acid and potash are necessary* for the full development of farm crops, and that the different crops have different capacities for using them; it is also true that when no increase in the crop follows the proper application of any one or all of these elements, the crop has sources at command which provide sufficient quantities to develop it to that limit fixed by the existing conditions of climate and season.

In view of these facts, the *best fertilizer* resolves itself into the *best or most economical quantity of nitrogen, phosphoric acid or potash to be used under the varying conditions of crop, soil and season.* It is obvious, therefore, that an accurate and definite answer to the first question is impossible.

A careful study of the different crops, and their capacities for using the different elements, however, furnishes data which may be used within reasonable limits in answering the question how much should be used per acre.

The amount and proportion of the elements that may be found profitable for the different crops under average conditions, are indicated in the following table:

Average Amounts of Nitrogen, Phosphoric Acid and Potash per Acre.

	Crops.	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash. lbs.
No. 1.	Wheat, Oats, Rye, Corn.	16	40	30
" 2.	Potatoes and Roots	20	25	40
" 3.	Garden Produce	30	40	60
" 4.	Fruit Trees	25	40	75
" 5.	Clover, Beans, Peas, etc.	...	40	60

Individual farmers must determine for themselves whether for their land and their crops *single elements* may not be more profitable than any combination of two or more; the physical condition of the soil, and its previous cropping and manuring must also guide the farmer in deciding whether the amounts given in the table should be increased or diminished. As a broad general rule, *greater immediate profits* are secured from *heavy dressings* on land in a high state of cultivation, than on farms of average fertility.

FORMULAS FOR MIXTURES.

In order to supply the amounts of nitrogen, phosphoric acid and potash to the different crops as indicated in the last table, the following formulas have been prepared:

No. 1.—Wheat, Oats, Rye, Corn.

To make 1,000 lbs. of Mixture.		Containing Pounds of	Application per Acre.
Nitrate of Soda	100 lbs.		
Sulphate of Ammonia	50 "	Nitrogen ... 40.	
Dried Blood, High Grade	100 "		400 lbs.
Bone-Black Superphosphate	600 "	Phosphoric Acid ... 96.	
Muriate of Potash	150 "	Potash ... 75.	

No. 2. Potatoes and Roots.

To make 1,000 lbs. of Mixture.		Containing Pounds of	Application per Acre.
Nitrate of Soda	125 lbs.		
Sulphate of Ammonia	100 "	Nitrogen ... 51.	
Dried Blood, High Grade	75 "		400 lbs.
Bone-Black Superphosphate	400 "	Phosphoric Acid ... 64.	
High-Grade Sulphate of Potash	100 "	Potash ... 102.	
Double Sulphate of Potash	200 "		

No. 3. Garden Produce.

To make 1,000 lbs. of Mixture.		Containing Pounds of	Application per Acre.
Nitrate of Soda	100 lbs.		
Sulphate of Ammonia	125 "	Nitrogen ... 54.	
Ammonite, High Grade	100 "		600 lbs.
Bone-Black Superphosphate	400 "	Phosphoric Acid ... 64.	
Muriate of Potash	110 "	Potash ... 98.	
Double Sulphate of Potash	165 "		

No. 4. Fruit Trees.

To make 1,000 lbs. of Mixture.		Containing Pounds of	Application per Acre.
Nitrate of Soda	250 lbs.	Nitrogen ... 47.	
Ground Bones	200 "	Phosphoric Acid ... 80.	500 lbs.
Bone-Black Superphosphate	250 "		
Muriate of Potash	300 "	Potash ... 150.	

The following formula may be substituted for No. 4, with the additional application in the spring of 100 lbs. per acre of nitrate of soda:

To make 1,000 lbs. of Mixture.		Containing Pounds of		Application per Acre.
Ground Bone	300 lbs.	Nitrogen	11.	350 lbs.
Bone-Black Superphosphate	300 "	Phosphoric Acid	108.	
Muriate of Potash	400 "	Potash	200.	

No. 5. Clover, Beans, Peas, etc.

To make 1,000 lbs of Mixture.		Containing Pounds of		Application per Acre.
Black-Bone Superphosphate	500 lbs.	Phosphoric Acid	80.	500 lbs.
Muriate of Potash	150 "	Potash	120.	
Kainit	350 "			

An application of 500 pounds per acre of a mixture of 350 pounds of S. C. rock superphosphate and 650 pounds of kainit, would furnish the same amounts of phosphoric acid and potash as No. 5, and would be equally good, though such a mixture would have a tendency to harden.

The best forms of fertilizing materials were used in the preparation of these formulas, as they will probably be found to be the cheapest in the majority of cases. These are as a rule in good mechanical condition, and can be bought direct from the leading dealers or manufacturers, and should in all cases be accompanied by a guaranteed composition.

MIXING.

It is important that the materials should be evenly mixed. This can be easily done by forming on the barn floor or other dry and level place, a series of layers of the different materials and working the heap over from the edge outwards, breaking all the lumps in the process; a few turnings will suffice to answer the purpose. Screening is also advisable if suitable apparatus is at hand.

It is not claimed that the buying of raw materials and mixing at home is the best and cheapest method of getting fertilizers under all conditions; however, the important points in favor of the method will bear repeating, viz.:

1. *That a definite knowledge of the quality of the materials is secured;* and

2. *That where farmers know what they want and unite in purchasing car lots, there is a decided saving in the cost of the plant-food.*

The Station recommends that both individual farmers and farmers' clubs give this method a practical trial, and it is ready to co-operate

with them so far as to make such analyses of the goods bought as is deemed wise. It is desired, therefore, that when unmixed materials are purchased either for application singly or for home mixing, the parties so buying notify the Station, in order that the properly authorized persons may procure samples, and forward them to the Station.

ANALYSES OF INCOMPLETE FERTILIZERS.

The analyses of incomplete fertilizers published in the following tables show:

1. The composition of standard and miscellaneous fertilizer supplies.

2. The actual cost per pound of the nitrogen, phosphoric acid and potash in the material furnished to farmers by the manufacturers represented.

Standard materials like nitrate of soda, sulphate of ammonia, bone black and South Carolina rock superphosphates, and the different potash salts, vary in composition within reasonably narrow limits, and almost invariably contain the full amount of the element guaranteed.

Superphosphates are now often sold on what is termed the unit basis; the unit means one per cent. per ton, or 20 pounds. For example, a quotation of $1 per unit of available phosphoric acid would mean $1 for each *twenty pounds* contained in the material. Contracts on this basis are perfectly fair for both buyer and seller, though it is quite as necessary to establish by analysis the number of units per ton as to determine the amounts contained when guaranteed on the per cent. basis.

With few exceptions, the samples were taken from goods in the hands of the farmers, and which had been bought for cash direct from the manufacturers of complete fertilizers. The cost per pound of the nitrogen, phosphoric acid and potash in these materials, represents the manufacturers' retail prices at factory, and therefore admit of a comparison with the Station's schedule of valuations, which are intended to represent the retail cash cost per pound of the nitrogen, phosphoric acid and potash in the raw materials containing these elements before they are mixed to form a complete fertilizer. When the retail price at point of consumption is noted in the tables, the cost per pound of the element is not included in the average.

FORMS OF NITROGEN

Readily and Completely Soluble in Water.

NITRATE OF SODA

Furnishing Nitrogen in Form of Nitrates.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage of Nitrogen.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Nitrate of Soda.
			cts.	
3382	I. P. Thomas & Son Co., Philadelphia	15.89	14.0	$44 50
3426	Sharpless & Carpenter, "	16.03	18.2	*58 50
3465	H. S. Miller & Co., Newark	16.18	15.3	*49 50
3469	The Taylor Provision Co., Trenton	16.09	14.0	45 00
3708	The Tygert-Allen Fertilizer Co., Philadelphia	15.55	14.5	45 00
3868	Bowker Fertilizer Co., Boston and New York	15.60	17.7	*55 00
Average Cost per Pound of Nitrogen in Nitrate of Soda			14.2	

* Retail price at point of consumption.

SULPHATE OF AMMONIA

Furnishing Nitrogen in Form of Ammonia.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage of Nitrogen.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Sulphate of Ammonia.
			cts.	
3388	I. P. Thomas & Son Co., Philadelphia	20.12	16.8	$67 50
3414	M. L. Shoemaker & Co., "	19.96	17.6	70 00
3428	Sharpless & Carpenter, "	20.80	20.7	*86 00
3468	H. S. Miller & Co., Newark	20.61	17.0	*70 00
3470	The Taylor Provision Co., Trenton	20.66	16.2	67 00
3709	The Tygert-Allen Fertilizer Co., Philadelphia	20.46	17.1	70 00
Average Cost per Pound of Nitrogen in Sulphate of Ammonia			16.9	

* Retail price at point of consumption.

FORMS OF NITROGEN INSOLUBLE IN WATER

Furnishing Nitrogen in Form of Organic Matter.

DRIED AND GROUND FISH.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage.		Cost Per Pound.		Cost of 2,000 lbs of Fertilizer.
		Nitrogen.	Phosphoric Acid.	Nitrogen.	Phosphoric Acid.	
				cts.	cts.	
3483	Bowker Fertilizer Co., Boston and New York	8.88	6.65	16.5	7	$37 00
3644	Sharpless & Carpenter, Philadelphia	8.92	7.14	15.7	7	38 00
3813	Kirby & Smith, Woodbury	10.12	1.15	13.3	7	28 50
3858	James E. Otis, Tuckerton	6.85	9.16	11.7	7	28 80
3872	Bowker Fertilizer Co., Boston and New York	8.37	7.65	13.9	7	34 00
3873	Sharpless & Carpenter, Philadelphia	9.23	7.90	12.4	7	34 00
3874	J. C. Fifield & Sons, Bakersville	8.23	7.85	15.2	7	36 00
Average Cost per Pound of Nitrogen				14.1		
3895	Crude Fish Guano*	4.81	7.45	11.5	4.7	$18 00

* From Geo. M. Wells, Moorestown; sample coarse and wet.

FORMS OF NITROGEN INSOLUBLE IN WATER

Furnishing Nitrogen in Form of Organic Matter.

TANKAGE.

Station Number.	NAME AND ADDRESS OF DEALER.	Mechanical Analysis.				Chemical Analysis.		Selling Price at Factory of 2,000 pounds.
		Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch.	Finer than 1/8 inch.	Nitrogen.	Phosphoric Acid.	
3624	Hog Tankage. The Taylor Prov. Co., Trenton	56	22	15	7	6.06	14 76	$28 00
3875	Blood Tankage. John Bowers & Co., Phila.....	22	35	18	25	8.04	8.83	28 00

Station Number.		Cost of Phosphoric Acid per Pound in—				Cost of Nitrogen per Pound in—			
		Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch.	Finer than 1/8 inch.	Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch.	Finer than 1/8 inch.
		cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
3624	The Taylor Provision Co......................	5.5	4.7	3.9	3.1	12.9	10.2	8.2	6.7
3875	John Bowers & Co..............................	6.7	5.7	4.8	3.8	15.7	12.4	10.0	8.1
Average Cost per Pound......................		6.1	5.2	4.3	3.4	14.3	11.3	9.1	7.4
Station's Prices..		7.0	6.0	5.0	4.0	16.5	13.0	10.5	8.5

DRIED BLOOD.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage of Nitrogen.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Dried Blood.
			cts.	
3471	The Taylor Provision Co., Trenton	12.02	16.0	$38 40

COTTON-SEED MEAL.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage.			Cost Per Pound.			Cost of 2,000 lbs. of Fertilizer.
		Nitrogen.	Phosphoric Acid.	Potash.	Nitrogen.	Phosphoric Acid.	Potash.	
					cts	cts.	cts.	
3416	J. J. Wikoff, Princeton Junction..................	6 28	3.71	1.59	13.5	7.0	6.0	$24 00
3537	S. C. Parker, Vineland....................................	7.54	3 42	0.99	12.0	7.0	6.0	24 00
Average Cost per Pound of Nitrogen..					12.8			

PLAIN SUPERPHOSPHATES

Furnishing Soluble, Reverted and Insoluble Phosphoric Acid.

MANUFACTURED FROM

BONE BLACK, BONE ASH, ETC., ETC.

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	Phosphoric Acid.					Cost per Pound.			Cost of 2,000 Pounds of Fertilizer.
					Available.		Phos. Acid.			
		Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Found.	Guaranteed	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	
							cts.	cts.	cts.	
3386	I. P. Thomas & Son Co., Phila..	16.08	0.05	0.80	16.08	....	5.9	5.9	....	*
3467	H. S. Miller & Co., Newark......	16.46	0.04	0.09	16.50	....	7.3	7.3	1.8	†$24 00
3472	The Taylor Prov. Co., Trenton	15.12	....	0 13	15.12	....	6.2	6.2	1.6	19 00
3711	Tygert-Allen Fert. Co., Phila...	16 68	0.64	0.60	17.32	....	7.2	7.2	1.8	25 00
Average Cost Per Pound of Phosphoric Acid.....................							6.7	6.7	1.7	

*$1.18 per unit of available phosphoric acid.
† Retail price at point of consumption.

PLAIN SUPERPHOSPHATES

Furnishing Soluble, Reverted and Insoluble Phosphoric Acid.

MANUFACTURED FROM

SOUTH CAROLINA ROCK AND OTHER MINERAL PHOSPHATES.

Station Number.	NAME AND ADDRESS OF MANUFACTURER.	Phosphoric Acid.					Cost per Pound.			Cost of 2,000 Pounds of Fertilizer.
					Available.		Phos. Acid.			
		Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Found.	Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	
							cts.	cts.	cts.	
3385	I. P. Thomas & Son Co., Phila..	10.37	2.17	2.96	12.54	....	5.4	5.4	....	*
3422	Sharpless & Carpenter, Phila...	9.84	1.23	5.24	11.07	....	5.2	5.2	1.3	$13 00
3710	Tygert-Allen Fert. Co., Phila...	9.96	1.45	3.05	11.41	....	6.2	6.2	1.5	15 00
Average Cost per Pound of Phosphoric Acid.........................							5.6	5.6	1.4	

*$1.08 per unit of available phosphoric Acid.

DISSOLVED BONE.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage.					Cost per Pound.				Cost of 2,000 Pounds of Fertilizer.
			Phosphoric Acid.					Phos. Acid.			
		Nitrogen.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble	Available Found.	Nitrogen.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	
							cts.	cts.	cts.	cts.	
3415	John I. Smith. Trenton............	4.18	5.15	6.92	1.52	12.07	17	5.5	5.5	1.3	$28 00

GERMAN POTASH SALTS

Readily Soluble in Distilled Water.

MURIATE OF POTASH.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage of Potash.	Cost of Potash per lb.	Cost of 2,000 lbs. of Muriate.
			cts.	
3387	I. P. Thomas & Son Co., Philadelphia	50.87	4.2	$42 00
3417	M. L. Shoemaker & Co., "	48.56	3.9	38 00
3466	H. S. Miller & Co., Newark	47.76	5.2	*49 50
3473	The Taylor Provision Co., Trenton	50.96	4.2	42 50
3623	" " " " "	51.68	4.0	41 00
3712	The Tygert-Allen Fertilizer Co., Philadelphia	48.80	4.6	45 00
3869	H. S. Miller & Co., Newark	53.12	4.0	42 00
	Average Cost per Pound of Potash in Muriate		4.2	

*Retail price at point of consumption.

KAINIT.

Station Number.	NAME AND ADDRESS OF DEALER.	Percentage of Potash.	Cost of Potash per lb.	Cost of 2,000 lbs. of Kainit.
			cts.	
3391	Paul Weidinger, New York	12.40	4.8	$12 00
3698	Taylor Bros., Camden	11.89	5.5	13 00
3870	H. S. Miller & Co., Newark	12.89	4.8	12 00
3871	Sharpless & Carpenter, Philadelphia	12.29	6.1	*15 00
3423	" " "	12.51	6.3	*15 75
	Average Cost per Pound of Potash in Kainit		5.0	

*Retail price at point of consumption.

3418. High-Grade Sulphate of Potash, from M. L. Shoemaker & Co., Philadelphia.
3667. Sylvinit. from The Taylor Provision Co., Trenton.

ANALYSES.

	3418.	3667.
Per cent. of Potash	49.70	14,83
Cost per ton	$55 00	$16 00
Cost per pound of Potash	5.5 cts.	5.4 cts.

3489. Cotton-hull ashes, from National Cotton Oil Co., New York. Cost per ton, $30. It contains 0.80 per cent. soluble, 6.41 per cent. reverted and 3.55 per cent. insoluble phosphoric acid, and 30.40

per cent. potash soluble in water. The cost per pound of potash is **2.8*** cents.

3625. Ground tobacco stems, from The Taylor Provision Co., Trenton. Cost per ton, $20. It contains 0.99 per cent. nitrogen as nitrate, 1.69 per cent. as organic matter, 1.11 per cent. total phosphoric acid and 9.31 per cent. potash free from chlorides. The cost per pound of potash is **5.3*** cents.

The potash in cotton-hull ashes is free from chlorides and exists chiefly as phosphate and carbonate of potash. In the sample reported, it is furnished much cheaper than from high-grade sulphate or even muriate of potash. Cotton-hull ashes are, however, not uniform in composition, and hence, with a uniform price per ton, wide differences occur in the cost per pound of actual potash. This point is very distinctly shown in Bulletin 103 of the Connecticut Experiment Station, where, in the twelve samples analyzed, the percentages of potash ranged from 15.57 to 30.24, and the cost of potash from 8.6 to 1.5 cents, with an average cost per pound of 5.3 cents.

Sample 3625 is reported to be a waste product from a cigar manufactory in St. Louis, Missouri, "where the leaf is stripped from the stem, after which the stems are dried and ground." The percentage of nitrate nitrogen in this sample is much higher than is shown by the analyses of tobacco stems heretofore published. A number of samples, sent to the Entomologist of this Station for use as insecticides, were also found to contain comparatively large quantities of nitrate nitrogen. A large amount of the potash in No. 3625 probably exists as nitrate of potash; the remainder is in organic combination, though quite freely soluble in water.

THE VALUE OF HOME MIXTURES.

A study of the home mixtures shows: That the total cost of each of those here represented is *less* than the commercial value, at Station's prices, of the actual plant-food elements furnished by them.

Except the ground bone and high-grade and double sulphate of potash, the analyses of the materials used to form these mixtures are published in the preceding tables; the commercial valuations of the mixtures are therefore based upon the number of pounds of nitrogen, phosphoric acid and potash found by these analyses.

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*Allowing the Station's schedule of prices for the different forms of nitrogen and for phosphoric acid.

J. H. DENISE'S MIXTURE.

COMPOSITION.	COST.
270 pounds of Sulphate of Ammonia, at $70.00 per ton	$9 45
100 " " Nitrate of Soda, at $49.50 per ton	2 48
330 " " Ground Bone, at $28 00 per ton	4 62
850 " " Bone-Black Superphosphate, at $24 00 per ton	10 20
450 " " Muriate of Potash, at $49.50 per ton	11 14
2,000 pounds cost	$37 89
Cost of mixing per ton	1 00
Total cost per ton	$38 89
Value per Ton at Station's Prices	**$39 05**

W. S. RIGG'S MIXTURE.

COMPOSITION.	COST.
100 pounds of Sulphate of Ammonia, at $70.00 per ton	$3 50
700 " " Dissolved Bone, at $28.00 per ton	9 80
800 " " Cotton-Seed Meal, at $24.00 per ton	9 60
400 " " High-Grade Sulphate of Potash, at $55.00 per ton	11 00
200 " " Muriate of Potash, at $38.00 per ton	3 80
2,200 pounds cost	$37 70
2,000 " "	34 28
Freight per ton	1 00
Cost of mixing per ton	1 00
Total cost per ton	$36 28
Value per Ton at Station's Prices	**$38 18**

J. B. FIELD'S MIXTURE.

COMPOSITION.	COST.
250 pounds of Nitrate of Soda, at $45.00 per ton	$5 63
200 " " Sulphate of Ammonia, at $67.00 per ton	6 70
150 " " High-Grade Blood, at $38.40 per ton	2 88
800 " " Bone-Black Superphosphate, at $19.00 per ton	7 60
200 " " High-Grade Sulphate of Potash, at $57.00 per ton	5 70
400 " " Double Sulphate of Potash, at $30.00 per ton	6 00
2,000 pounds cost	$34 51
Freight per ton	1 00
Cost of mixing per ton	1 00
Total cost per ton	$36 51
Value per Ton at Station's Prices	**$38 09**

It was stated in Bulletin 66 of this Station that the points in favor of buying raw materials and mixing at home were:

1. That a definite knowledge of the quality of the materials is secured; and

2. That where farmers know what they want and unite in purchasing car lots, there is a decided saving in the cost of the plant-food.

The goods of Mr. Denise were not bought direct from the factory, and therefore the cost includes the profit of the dealer. In the other cases the materials bought were less than a car-load, hence the usual gain from buying in large quantities, and the consequent decrease in freight rates, were not secured. *Yet in every case the cost per ton is less than the Station's valuations.*

While the differences between the cost per ton and the Station's valuations of these mixtures are not wide, the actual profit to be derived by farmers from this method of buying plant-food, becomes more apparent when the following points are taken into consideration:

1. That of the 178 samples of complete fertilizers examined by this Station in 1889, in 9 only the commercial value exceeded the selling price, and the average selling price exceeded the average Station's valuations by $5.76 per ton, or 19 per cent.

2. That of the analyses of the 79 samples published in Bulletin 69, but 4 exceeded in value the selling price, while the average selling price per ton was $7, or 26 per cent. greater than the average Station's valuation.

It is therefore distinctly shown that in buying the unmixed materials—

1. *There is a decided saving in the cost of plant-food.*

2. That the *rate of saving* depends upon whether the farmer *is now an average buyer* of complete fertilizers, buying at random, or whether he selects his brands from those manufacturers who furnish the most and best materials for the least money.

A sample of the mixture of Mr. Field was analyzed. Calculations based upon the analyses of the raw materials used, indicate that an even mixture should contain total nitrogen, 5.00 per cent., available phosphoric acid, 6.00 per cent., and potash, 10.40 per cent. The mixture *actually contained* 5.66 per cent. total nitrogen, 5.58 per cent. available phosphoric acid, and 10.63 per cent. potash, an analysis quite as close to the guarantee as some of the best brands of complete fertilizers, and indicates that farmers *can*, without special facilities, make relatively even mixtures of high-grade raw materials.

3.

THE GUARANTEED CHEMICAL COMPOSITION AND RELATIVE COMMERCIAL VALUES OF FERTILIZERS.

An act to regulate the manufacture and sale of fertilizers.

[Laws of New Jersey for 1874, page 90.]

1. That every commercial fertilizer which shall be offered for sale in this state shall be accompanied by an analysis, stating the percentage therein of ammonia, or its equivalent of nitrogen; of potash, in any form or combination, soluble in distilled water; and of phosphoric acid in any form or combination; the portion of phosphoric acid soluble in distilled water; that portion soluble in a neutral solution of citrate of ammonia at a temperature not exceeding one hundred degrees Fahrenheit; and that portion of phosphoric acid not soluble in either of the above-named fluids, shall each be determined separately; and the material from which the phosphoric acid is obtained shall also be stated; a legible statement of such analysis shall accompany all packages or lots of over one hundred pounds sold, offered or exposed for sale.

5. That any person selling, offering or exposing for sale any commercial fertilizer without the analysis required by the first section of this act, or the act to which this act is a supplement, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense; *provided further*, that the provisions of this section, or the act to which this act is a supplement, shall not apply to any manure sold at a price not exceeding one-half a cent per pound, nor to any imported guanos.

THE GUARANTEED CHEMICAL COMPOSITION OF FERTILIZERS.

From the Station's standpoint this subject involves—

1st. The sampling.
2d. The selection of samples.
3d. The chemical analysis.

Previous to the year 1884 all samples of fertilizers analyzed in this laboratory were drawn either by the Station's officials or by reputable farmers who had reasons for suspecting the quality of the brands bought for their own use. This system had many disadvantages and has been abandoned. At present the only samples received for analysis are those taken by duly authorized Inspectors.

This plan has been satisfactory to both consumers and producers, for the Inspectors are, without exception, farmers of the highest standing, who undertake the work solely because it is regarded as a matter of vital interest to the farming community.

The names of those who have represented this Station during the past season are as follows:

Charles Kraus	Egg Harbor City	Atlantic county.
Jacob B. Eckerson	River Vale	Bergen county.
H. I. Budd	Mount Holly	Burlington county.
I. W. Nicholson	Camden	Camden county.
J. H. Richardson	Rio Grande	Cape May county.
Theo. F. Baker	Bridgeton	Cumberland county.
Wm. R. Ward	Newark	Essex county.
J. C. Griscom	Woodbury	Gloucester county.
Augustus Dilts	Copper Hill	Hunterdon county.
Franklin Dye	Trenton	Mercer county.
J. M. White	New Brunswick	Middlesex county.
J. H. Denise	Freehold	Monmouth county.
J. J. Mitchell	Whippany	Morris county.
Geo. A. MacBean	Lakewood	Ocean county.
J. G. Jefferies	Mountain View	Passaic county.
Woodnutt Pettit	Salem	Salem county.
J. V. D. Pumyea	Plainville	Somerset county.
D. R. Warbasse	Hunt's Mills	Sussex county.
Dennis C. Crane	Roselle	Union county.
Thomas M. Boyer	Bridgeville	Warren county.

At the beginning of the season, each Inspector was furnished with a sampling tube, blanks for describing samples, bottle labels, etc., together with printed instructions regarding their uses, and each Inspector was requested to secure a sample of every brand of complete fertilizer which he could find in his district. As fast as samples were found they were shipped to New Brunswick, where they were properly numbered and stored.

A copy of the instructions, under which all samples were taken, is as follows:

DIRECTIONS TO BE FOLLOWED IN SAMPLING FERTILIZERS.

Inspectors may sample fertilizers found either—

First—Upon farms;
Second—In dealers' storehouses; or,
Third—In manufactories.

The Station prefers that samples should be drawn either upon farms or in dealers' storehouses.

In sampling fertilizers found upon farms, Inspectors should ascertain—

First—That the samples are not taken from stock of a past season or from stock which is or has been carelessly stored.

Second—That they were received in good condition; and have since been so stored that a noticeable gain or loss of moisture has been prevented.

In sampling from *dealers' storehouses*, Inspectors should also ascertain whether the fertilizers are of old (last season's) or of new stock. Preference should always be given to the present season's goods. Circumstances may, however, make it advisable to sample old stock; in such cases, this fact must be distinctly stated by the Inspector, in his report to the Station's Director.

If for any reason it is found to be necessary to draw samples at factories, Inspectors should decline—

First—To sample from piles of fertilizers.

Second—To sample from bags which are not distinctly marked with the brand, the manufacturer's name and the guaranteed analysis.

If fertilizers are found stored in piles only, Inspectors should cause six or more bags to be filled from different portions of the piles; from these bags the samples may be drawn in the usual manner.

Whenever the mechanical condition will allow, samples should be drawn by means of the *sampling tube* furnished by the Station.

It is not desirable to sample lots of less than one-half ton of any one brand. In such small lots portions may be taken from each bag; in larger lots each fifth or tenth bag may be opened. The several portions representing the same brand should then be carefully mixed and a quart fruit jar filled, securely closed and marked with labels furnished by the Station.

As soon as a sample has been taken, and *invariably* before bags of another brand have been opened, the Inspector should carefully fill out the blank describing samples.

He should copy *from the bags*—

First—The brand.
Second—The name of the manufacturer.
Third—The guaranteed analysis.

Other information needed for the description must be got from the owner of the fertilizer.

Each sample bottle should be separately wrapped in heavy paper, and packed for transportation in a wooden box, properly closed. This box should be forwarded by express, directed to

THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION,
New Brunswick, N. J.

FERTILIZERS.

Form for Description of Sample.

The person sending samples to the Station for analysis without charge, will be provided with a form like this for each sample, and must fill up every one of the blank particulars given, so as to make the description complete and definite, and in every case write his signature, as indorsing the accuracy of it. As there is much responsibility in taking fair average samples, such as will justly represent the manufacturer as well as the consumer, it is very important that every precaution be taken, so that in case of a suit at law the person signing the description can testify to its accuracy. The writing should be plain and legible. The filled-out form, if wrapped with the sample, will serve as a label. If any printed circular, pamphlet, analysis or statement accompanies the fertilizer, or is used in its sale, send a copy with the specimen.

1. Brand of fertilizer..
2. Name and address of manufacturer..
....
3. Name and address of dealer from whose stock this sample is taken..........
....
4. Date of taking this sample..
5. Selling price per ton, hundred, bag or barrel......................................
6. Selling weight claimed for each package weighed..................................
7. Actual weights of packages opened..
8. Copy of analysis or composition affixed to packages of this fertilizer......
....
....
....
9. Signature of person taking sample..
   P. O. Address..

THE SELECTION OF SAMPLES.

The methods followed in this laboratory have been developed gradually ever since the Station was organized; very slight modifications only have been introduced during the past year.

Each spring a circular letter is addressed to the fertilizer manufacturers, requesting a list of all brands intended for the New Jersey trade. The returns are properly classified and arranged in such a manner that brands which Inspectors fail to find are known, and special searches for them can be instituted promptly.

As above stated, Inspectors are requested to sample all fertilizers offered for sale in their counties. Many duplicates are consequently received at New Brunswick, all of which are numbered, however, and an entry is made for each in an appropriate book.

CHEMICAL ANALYSIS.

The chemical analysis includes a test for the three forms of nitrogen, viz., as nitrates, as ammonia salts and as organic matter, and a quantitative determination of each when found. In all cases the total, soluble, reverted and insoluble phosphoric acid are determined. Potash and chlorine determinations are made in each sample, and the potash found in excess of that needed to form muriate of potash, with the chlorine present, is credited to the manufacturer as sulphate of potash.

This complete examination of each sample is of value in furnishing information regarding the kind and quality of the materials used in mixed fertilizers.

The section of the fertilizer law published as an introduction to this chapter, indicates that certain analyses must be made in this State according to prescribed methods; all others are left to the judgment of the chemists, and are those recommended by the Association of Official Agricultural Chemists.

The rules of this laboratory require that all determinations shall be made in duplicate, and that duplicates shall not be made upon the same day.

GUARANTEES.

Of the 206 samples of complete fertilizers examined this year, 106 do not reach their claim in respect to one or more elements; 4 only are below the guarantee in all respects; the remainder either exceed or are so near to the guarantee as to make hardly any appreciable differences when expressed in dollars and cents. Many show irregularity in mixing and carelessness in statement of guarantee, but no attempt at deliberate fraud has been discovered.

Sample **3759** is an instance of lack of care on the part of the manufacturer when goods are rebagged; it furnishes double the amount of phosphoric acid claimed, and but a fraction of the nitrogen and potash guaranteed.

Samples **3836** and **3878** also deserve comment, since the fertilizing elements furnished are, in both cases, much less than the manufacturers claim.

Carey Bros.' Celebrated Pure Dissolved Bone still appears in the State; its composition corresponds very closely to the previously published analyses of this brand, though the price has been reduced to $34 per ton.

VALUE OF GUARANTEES.

Guarantees are valuable as a guide in the purchase of fertilizers—

1. When they state truly the relative proportions of the different ingredients in a mixed fertilizer;

2. When they indicate that a sufficient amount of actual plant-food is present to warrant the selling price.

The analyses made this year, studied in reference to the above points, show 1st, that the guarantees in many cases *do not* indicate truly the *proportions* in which the nitrogen, phosphoric acid and potash exist in the brands sold; 2d, that the average value of the minimum amounts guaranteed in the various brands examined this year is, at Station's prices, $27.10 per ton, and that the average selling price of the same brands is $34.64 per ton; an average difference of $7.54.

The conditions which render guarantees *valuable as guides* in the purchase of fertilizers are therefore *not observed by all* the manufacturers who sell in this State. Improvements in the fertilizer trade in these particulars must come largely through the influence of the farmers themselves. Probably the most effective agencies in causing such improvements are 1st, definite knowledge of the actual analyses of the different brands; and 2d, a continued demand for those goods *only*, other things being equal, which fulfill the conditions mentioned.

During the past year five bulletins containing fertilizer analyses have been published:

No. 66. Devoted to Fertilizing Materials.
" 69. " " Complete Fertilizers.
" 71. " " Incomplete Fertilizers and Home Mixtures.
" 73. " " Complete Fertilizers.
" 74. " " Ground Bones and Miscellaneous Samples.

The circulation of these publications approximated 13,000 copies of each in this State alone.

THE RELATIVE COMMERCIAL VALUES OF FERTILIZERS.

The schedule of valuations prepared by experiment stations is intended to be used in explaining chemical analyses, and also to serve

as a guide to farmers who estimate the commercial value of fertilizers from their guaranteed analyses. The methods followed in making up this schedule and in testing its accuracy have already been published in detail in former reports.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals.

	CENTS PER POUND.		
	1888.	1889.	1890.
Nitrogen in Ammonia Salts	17½	19	17
" " Nitrates	16	17	14½
" " Dried and Fine Ground Fish	16½	19	17
Organic Nitrogen in Dried and Fine Ground Blood	16½	19	17
" " " Meat	16½	19	17
" " " Cotton-Seed and Linseed Meal and in Castor Pom..	16½	15	15
" " " Fine Ground Bone	16½	16½	16½
" " " Fine Medium Bone	13	13	13
" " " Medium Bone	10½	10½	10½
" " " Coarse Medium Bone	8½	8½	8½
" " " Coarse Bone, Horn Shavings, Hair and Fish Scrap.	8	8	8
Phosphoric Acid, soluble in Water	8	8	8
" " " " Ammonium Citrate*	8	8	8
" " insoluble in Dry, Fine Ground Fish and in Fine Bone.	7	7	7
" " " " Fine Medium Bone	6	6	6
" " " " Medium Bone	5	5	5
" " " " Coarse Medium Bone	4	4	4
" " " " Coarse Bone	3	3	3
" " " " Fine Ground Rock Phosphate	2	2	2
Potash as High-Grade Sulphate	5½	6	6
" " Kainit	4¼	4½	4½
" " Muriate	4¼	4½	4½

*The solubility of phosphates, in ammonium citrate solutions, is seriously affected by heat. An Act of the Legislature (see Laws of New Jersey, 1874, page 90) provides that in this determination the temperature used shall not exceed 100° Fah.; in Connecticut, Massachusetts and Pennsylvania 150° Fah. has been adopted. The higher the temperature the larger will be the percentage of phosphoric acid dissolved by ammonium citrate solutions, and the larger the amount of this so-called "reverted" phosphoric acid in a ton of superphosphate the lower will be the price per pound of said acid. Consequently the Stations' valuations of phosphoric acid, soluble in ammonium citrate, have been fixed at *seven and one-half cents per pound* for Connecticut, Massachusetts and Pennsylvania, and at *eight cents per pound* for New Jersey.

Before this schedule was used by this Station its accuracy was subjected to the following severe test: Forty-seven samples of crude materials, including all the best sources of plant-food, were collected, analyzed, and the retail cost of their nitrogen, phosphoric acid and potash accurately determined. The schedule secured in the above manner, of *manufacturers' average retail cash prices* for plant-food in fertilizer supplies, has already been considered in detail in this report.

In the following table the manufacturers' average retail prices for 1889 and 1890 are given; the Station's schedule of prices for 1890 is also tabulated for comparison:

Comparison Between Station's Schedule and Manufacturers' Average Retail Prices of Plant-Food in Fertilizer Supplies.

	MANUFACTURERS' AVERAGE RETAIL PRICES FOR		STATION'S SCHEDULE OF PRICES FOR
	1889.	1890.	1890.
	cts.	cts.	cts.
Cost per pound of Nitrogen from Nitrate of Soda	16.0	14.2	14½
" " " " " " Sulphate of Ammonia	17.2	16.9	17
" " " " " " Dried Blood	20.0	16.0	17
" " " " " " Dried Fish and Ammonite	14.8	14.1	17
" " " " " " Cotton-Seed Meal	*14.9	12.8	15
" " " " Soluble Phosphoric Acid from Bone Black	7.4	6.7	8
" " " " " " " " S. C. Rock	6.1	5.6	8
" " " " Reverted " " " Bone Black	7.4	6.7	8
" " " " " " " " S. C. Rock	6.1	5.6	8
" " " " Insoluble " " " Bone Black	1.8	1.7	2
" " " " " " " " S. C. Rock	1.5	1.4	2
" " " " Potash from High-Grade Sulphate	5.6	5.5	6
" " " " " " Double Sulph's of Pot. and Mag.	6.0	....	6
" " " " " " Kainit	4.8	5.0	4½
" " " " " " Muriate	3.9	4.2	4½

*And castor pomace.

With the exception of potash salts, wholesale prices of raw materials declined during the latter part of 1889 and the early part of 1890. The results show that the retail prices of manufacturers

are also much lower for nitrogen and phosphoric acid than in 1889. Station's prices were decreased this year only in the case of nitrogen. A study of the table shows that while Station's prices of nitrogen and potash agree quite closely with the manufacturers' average retail prices, in the case of phosphoric acid, the Station's prices are over 30 per cent. greater than the prices at which available phosphoric acid *has been bought* by farmers direct from the manufacturers.

RETAIL PRICES.

In order to draw a fair comparison between cost per ton and commercial valuation of complete fertilizers, the cost should be fixed at definite points, viz., the factories. The efforts of the Station in the past to secure prices at these points have not been encouraging, and the Station has made no attempt this year to continue them. The retail prices only at points where samples have been drawn have been published. The attention of the farmers is here called to the fact that the differences which exist between the cost per ton at these points, and the Station's estimated values per ton, may be due to mixing and bagging expenses, freight rates, commissions, etc. These are variable conditions, depending upon the location of the works, the knowledge and facilities of the manufacturers, and the skill of the employes. Estimates received by the Station from leading manufacturers indicate that the mixing and bagging expenses average $2.85 per ton. Freight rates on single tons will probably not average higher than $2 throughout the State.

The important question to be considered by the farmer is: Are the variations which exist between the commercial value and the selling price wider than legitimate conditions warrant?

A comparison of the two hundred and six brands examined this year shows that the retail price in seventy-nine brands ranges from $5.33 per ton *less* to $6 per ton more than the Station's valuation; in seventy-two, from $6 to $10 per ton more; and in fifty-four, or twenty-six per cent. of the whole number, from $10 to $18 per ton more, sample No. 3846 not being included.

The variations in guaranteed composition between the seventy-nine samples above indicated are as follows: Nitrogen ranges from 0.82 to 5.74 per cent., available phosphoric acid from 3.75 to 12.00 per cent. and potash from 0.65 to 11.00 per cent.

Commercial valuations may not in any case be a measure of agricultural values, and may even have a tendency to draw the attention of farmers from the composition of the brands to commercial comparisons; yet, while it is not assumed that the differences between selling price and Station valuations are too wide in any of the brands here published, a study of these comparisons develops three important points, viz., that the thirty-one brands which come the nearest in value to their selling price, are those which, *as a rule*—

1. *Equal or exceed their guarantee* in plant-food furnished;
2. Contain the *best forms of plant-food*, and therefore furnish the *most* and *best* for the money paid; and
3. Provide quite as wide a choice of special composition as is desirable.

GENERAL SUGGESTIONS.

It is admitted by most farmers that fertilizers pay; *how to buy* and *how to use* are questions which are becoming clearer each year. Yet, the large number of brands from which to select is at times confusing to those who are influenced by *names of brands* and *prices per ton*. The fact that any brand reaches its guarantee in contained plant-food, or that it corresponds closely in estimated value to selling price, is not evidence in itself that it is better than some other brands which do not reach their claims in this respect. In addition to these points the guarantee must be high enough to *warrant the price*, and the contained plant-food must be the *kind that is needed*.

Attention cannot be too often called to the fact that *nitrogen, phosphoric acid and potash* are the elements sought for in a complete fertilizer; the amount, kind and quality of these determine its commercial, and to a large degree its agricultural value.

As a rule, the fertilizer which contains the greatest amounts of these elements is the cheapest; for the cost of manufacture, freightage and rate of commission is the same for high-grade as for low-grade fertilizers, and the labor on the part of the farmer is increased as the grade of goods decreases.

The study of the work this year on complete fertilizers would seem to warrant the following conclusions, viz., *that it will pay farmers*—

1. To keep for study and reference the bulletins containing the analyses and valuations of fertilizers.

2. To buy of those manufacturers who sell what they claim, and who claim enough to warrant their selling price.

3. Before buying complete fertilizers, to study the wants of individual soils and crops in reference to the most suitable brands, rather than to trust to the judgment of others in regard to them.

In addition to the samples, 49 in number, reported upon a preceding page, the analyses may be found in the following tables of—

206 samples of Complete Fertilizers.
81 samples of Ground Bone.
7 samples of Dissolved Bone.
19 samples of Miscellaneous Products.

The following list may be used as an index to the tables of

COMPLETE FERTILIZERS.

LIST OF MANUFACTURERS WHOSE BRANDS HAVE BEEN SAMPLED AND ANALYZED THIS YEAR.

William T. Allen	Lawrence Station, N. J.
Allentown Manufacturing Co	Allentown Pa.
American Fish Guano Co	Hoffman's Wharf, Va.
H. J. Baker & Bro.	215 Pearl Street, New York City.
Baugh & Sons Co	20 South Delaware Avenue, Philadelphia, Pa.
Bowker Fertilizer Co	27 Beaver Street, New York City.
Brands & Reed	Belvidere, N. J.
Brown & Gilman	35 South Front Street, Philadelphia, Pa.
Carey Bros	Lumberville, Pa.
E. Frank Coe	16 Burling Slip, New York City.
Crocker Fertilizer and Chemical Co	60 Pearl Street, Buffalo, N. Y.
Dambmann Bros. & Co	227 East German Street, Baltimore, Md.
Darling Fertilizer Co	Pawtucket, R. I.
H. W. Doughten	Moorestown, N. J.
Equitable Fertilizer Co	Baltimore, Md.
J. C. Fifield & Sons	Bakersville, N. J.
Geo. B. Forrester	169 Front Street, New York City.
Garrison & Minch	Bridgeton, N. J.
J. C. Gaskill & Son	Mount Holly, N. J.
Theodore Glaser	Linden, N. J.
Great Eastern Fertilizer Co	Rutland, Vt.
H. B. Griffin	90 Cortlandt Street, New York City.
D. D. Hess & Son	Reading, Pa.
The Index Co., Limited	Philadelphia, Pa.
Lewis & Price	Smyrna, Del.
Lister's A. C. Works	Newark, N. J.
Lord & Polk Chemical Co	Odessa, Del.
Mapes' F. & P. Guano Co	158 Front Street, New York City.
C. Meyer, Jr	Maspeth, L. I.
H. S. Miller & Co	Newark, N. J.
Milsom Rendering and Fertilizer Co	Buffalo, N. Y.
A. Mitchell	Tremley, N. J.
Monmouth Fertilizer Co	708 Cookman Ave., Asbury Park, N. J.
National Fertilizer Co	Bridgeport, Conn.

J. E. & A. Nelson..Imlaystown, N. J.
New Jersey Chemical Co..........................129 S. Front St., Philadelphia, Pa.
James E. Otis...Tuckerton, N. J.
Pacific Guano Co..Boston, Mass.
Albert Parker. ....Mullica Hill, N. J.
Frederick Phillips..................................131½ S. Third St., Philadelphia, Pa.
H. Preston & Sons..Greenpoint, L. I.
The Provident F. & P. Co.............................112 Spruce St., Philadelphia, Pa.
Quaker City Odorless Excavating Co........601 Sansom St., Philadelphia, Pa.
Read Fertilizer Co...................................209 W. Genesee St., Syracuse, N. Y.
J. S. Reese & Co..New Bedford, Mass.
Shanley & Van Brunt...............................1429 Market St., Philadelphia, Pa.
Sharpless & Carpenter....................114 S. Delaware Ave., Philadelphia, Pa.
M. L. Shoemaker & Co...Venango St. and Delaware Ave., Philadelphia, Pa.
John I. Smith..Trenton, N. J.
Stearns Fertilizer Co.. ....133 Water St., New York City.
Taylor Bros..Camden, N. J.
The Taylor Provision Co.. ....Trenton, N. J.
I. P. Thomas & Son Co........................2 S. Delaware Ave., Philadelphia, Pa.
The Tygert-Allen Fertilizer Co.................2 Chestnut St., Philadelphia, Pa.
Walker, Stratman & Co...Pittsburgh, Pa.
Wando Phosphate Co.............................203 Walnut Place, Phildelphia, Pa.
Waring Manufacturing Co ....Baltimore, Md.
J. Wenderoth & Sons....................................1046 Cooper St., Camden, N. J.
Wilkinson & Co...................................52 and 54 William St, New York City.
Williams & Clark Fertilizer Co.......................81 Fulton St., New York City.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3573	Potato and Truck Manure	Wm. T. Allen, Lawrence Station, N. J.	Franklin Dye, Trenton.	3573
3574	Ammoniated Dissolved Bone with Potash	" " " " " "	" " "	3574
3577	Complete Phosphate	" " " " " "	" " "	3577
3892	" Bone Manure	Allentown Manufacturing Co., Allentown, Pa.	D. R. Warbasse, Hunt's Mills.	3892
3896	Germania Phosphate	" " " " "	J. J. Mitchell, Whippany.	3896
3897	Complete Bone Phosphate	" " " " "	" " "	3897
3806	Ocean Guano	American Fish Guano Co., Hoffman's Wharf, Va.	Jas. C. Griscom, Woodbury.	3806
3431	"A. A." Ammoniated Superphosphate	H. J. Baker & Bro., New York.	J. H. Denise, Freehold.	3431
3395	Turnip Manure	" " " " "	Theo. F. Baker, Bridgeton.	3395
3430	Pelican Bone Fertilizer	" " " " "	J. H. Denise, Freehold.	3430
3538	Potato Manure	" " " " "	H. I. Budd, Mount Holly.	3538
3785	Bone and Potash Compound for all crops	Baugh & Sons Co., Philadelphia, Pa.	" " " "	3785
3490	Stockbridge Potato Manure	Bowker Fertilizer Co., Boston and New York.	Woodnutt Pettit, Salem.	3490
3515	Sure Crop Bone Phosphate	" " " " " " "	Dennis C. Crane, Roselle.	3515
3764	Stockbridge Vegetable, Cabbage and Cauliflower	" " " " " " "	J. B. Eckerson, River Vale.	3764

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3573	Allen's Potato and Truck Manure............	1.60	0.21	1.82	3.63	3.28	7.68	0.32	1.25	9.25	....	8.00	8.00	3.47	3.00	3.14	$32.71	$37.00	3573
3574	" Am. Dissolved Bone with Potash...	0.71	......	0.93	1.64	1.64	3.64	0.81	1.64	11.09	....	9.45	7.00	1.99	2.00	4.36	23.11	25.00	3574
3577	" Complete Phosphate......................	0.97	......	1.94	2.91	2.46	7.70	1.34	4.00	13.04	12.00	9.04	10.00	1.54	2.00	1.64	27.66	30.00	3577
3892	Allentown Complete Bone	......	......	1.35	1.35	1.64	3.78	1.66	6.27	11.71	11.00	5.44	4.00	4.49	4.00	4.15	21.10	31.00	3892
3896	" Germania Phosphate...............	......	......	1.16	1.16	0.82	2.27	3.30	3.22	8.79	8.00	5.57	7.00	4.20	4.00	3.35	18.56	32.00	3896
3897	" Complete Bone Phosphate........	......	......	1.44	1.44	1.64	6.21	3.06	3.52	12.79	11.00	9.27	10.00	2.00	2.00	1.85	23.65	35.00	3897
3806	Ocean Guano..	......	0.73	1.26	1.99	1.85	1.11	3.36	7.56	12.03	11.00	4.47	8.00	1.28	1.00	1.54	19.61	32.00	3806
3431	Baker's "A. A." Ammoniated Superphos...	......	1.65	1.01	2.66	2.46	10.38	2.06	0.47	12.91	....	12.44	10.00	4.03	2.00	3.69	32.86	37.50	3431
3395	" Turnip Manure..............................	......	5.04	1.18	6.22	5.74	5.43	0.68	0.09	6.20	....	6.11	5.00	9.65	9.00	6.37	40.04	41.00	3395
3430	" Pelican Bone Fertilizer.................	.....	1.12	1.05	2.17	1.85	5.22	1.27	0.64	7.13	....	6.49	8.00	2.36	2.25	5.00	20.17	28.00	3430
3538	" Potato Manure..............................	......	3.52	0.76	4.28	3.28	5.04	2.87	0.68	8.09	....	7.41	5.75	9.76	10.00	5.06	36.52	42.00	3538
3785	Baugh's Bone and Potash Compound........	......	0.20	1.56	1.76	1.64	7.10	0.72	2.98	10.75	....	7.82	8.00	2.16	2.00	5.22	22.19	28.00	3785
3490	Bowker's Stockbridge Potato.....................	0.99	0.89	1.61	2.99	3.25	8.43	0.96	1.41	10.80	8.00	9.39	7.00	5.20	5.00	5.08	30.23	40.00	3490
3515	" Sure Crop Bone Phosphate........	0.40	0.11	0.64	1.15	0.82	2.19	4.46	3.14	9.79	10.00	6.65	8.00	1.75	1.00	3.46	17.81	24.00	3515
3764	" Stockbridge Vegetable, etc........	1.99	0.11	2.20	4.30	3.28	3.78	1.10	5.58	10.46	....	4.88	8.00	4.19	5.00	3.97	28.55	37.00	3764

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3581	Bone and Potash, Square Brand	Bowker Fertilizer Co., Boston and New York.	Franklin Dye, Trenton.	3581
3628	Grape Manure	" " " " " " "	H. I. Budd, Mount Holly.	3628
3719	Ammoniated Dissolved Bone	" " " " " " "	Augustus Dilts, Copper Hill.	3719
3739	Hill and Drill Phosphate	" " " " " " "	Dennis C. Crane, Roselle.	3739
3808	Fish and Potash, Square Brand	" " " " " " "	J. C. Griscom, Woodbury.	3808
3845	High Grade	" " " " " " "	Charles Kraus, Egg Harbor City.	3845
3899	Stockbridge Corn Manure	" " " " " " "	J. J. Mitchell, Whippany.	3899
3836	Standard	Brands & Read, Belvidere, N. J.	D. R. Warbasse, Huntsburgh.	3836
3878	Corn and Potato Special	" " " "	T. M. Boyer, Bridgeville.	3878
3837	Guano Phosphate	" " " "	D. R. Warbasse, Huntsburgh.	3837
3881	Peach Tree Special	" " " "	T. M. Boyer, Bridgeville.	3881
3882	Wheat Special	" " " "	" " "	3882
3883	Onion Manure	" " " "	" " "	3883
3478	Special Potato Manure	Brown & Gilman, Philadelphia, Pa.	J. H. Denise, Freehold.	3478
3604	No. 5 Bone Phosphate	" " " "	Franklin Dye, Trenton.	3604

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3581	Bowker's Bone and Potash, Square Brand	0.45	0.10	1.28	1.83	1.00	6.32	1.81	5.28	13.41	......	8.13	12.00	1.87	2.00	2.86	$23.36	$25.00	3581
3628	" Grape Manure	0.70	......	2.00	2.70	2.46	7.47	1.14	3.99	12.60	5.00	8.61	......	5.32	4.00	0.51	31.17	42.00	3628
3719	" Ammoniated Dissolved Bone	0.82	0.15	1.37	1.84	2.00	8.81	1.46	3.23	13.00	10.00	9.77	8.00	1.94	2.00	2.96	25.43	31.00	3719
3739	" Hill and Drill Phosphate	......	0.39	2.47	2.86	2.50	8.61	1.19	3.54	13.34	12.00	9.80	10.00	1.87	2.00	2.01	29.21	34.00	3739
3808	" Fish and Potash, Square Brand	......	......	2.81	2.81	2.25	7.52	1.08	3.94	12.54	8.00	8.60	......	3.56	4.00	3.81	28.87	35.00	3808
3845	" High Grade	1.21	0.74	1.64	3.59	3.28	6.81	1.74	1.77	10.32	9.00	8.55	8.00	7.15	8.00	4.93	32.95	36.00	3845
3899	Stockbridge Corn Manure	1.40	......	1.95	3.35	3.28	7.23	1.56	2.85	11.64	9.00	8.79	8.00	4.05	4.00	0.46	31.15	38.00	3899
3836	Brands & Read's Standard	......	0.13	0.05	0.18	0.82	0.12	0.17	0.07	0.36	9.00	0.29	......	3.78	3.00	8.21	4.51	17.00	3836
3878	" " Corn and Potato Special	......	0.17	1.10	1.27	0.82	1.78	1.30	1.32	4.35	......	3.03	9.00	4.67	5.00	3.77	14.16	28.00	3878
3837	" " Guano Phosphate	......	......	0.25	0.25	2.46	0.05	1.29	22.99	24.33	11.00	1.34	......	0.07	5.00	0.16	16.84	25.00	3837
3881	" " Peach Tree Special	......	......	2.24	2.24	1.23	0.90	5.15	7.05	13.10	......	6.05	12.00	4.01	4.33	9.36	25.14	30.00	3881
3882	" " Wheat Special	......	......	1.01	1.01	1.64	6.89	1.94	3.84	12.17	......	8.33	12.00	2.59	3.78	0.60	21.92	30.00	3882
3883	" " Onion Manure	......	0.10	1.06	1.16	1.64	1.86	1.82	2.08	5.76	12.00	3.68	......	3.79	3.24	7.69	14.49	28.00	3883
3478	Brown & Gillman's Special Potato Manure	......	0.19	2.14	2.33	2.46	5.01	0.71	3.30	9.02	......	5.72	6.00	6.02	6.00	5.94	24.49	36.00	3478
3604	" " No. 5 Bone Phosphate	......	0.24	1.52	1.76	0.82	5.82	0.76	5.34	11.92	......	6.58	6.00	1.29	1.00	2.61	20.88	28.00	3604

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3492	Superphosphate, No. 4	Brown & Gilman, Philadelphia, Pa.	Woodnutt Pettit, Salem.	3492
3846	Celebrated Pure Dissolved Bone	Carey Bros., Lumberville, Pa.	C. Kraus, Egg Harbor City.	3846
3439	Excelsior Guano	E. Frank Coe, New York.	J. H. Denise, Freehold.	3439
3598	Alkaline Bone	" " " " "	J. V. D. Pumyea, Plainville.	3598
3741	XXV. Ammoniated Bone Superphosphate	" " " " "	Dennis C. Crane, Roselle.	3741
3436	Peach Tree, Fruit and Grape Vine Fertilizer	" " " " "	J. H. Denise, Freehold.	3436
3438	High-Grade Ammoniated Bone Superphosphate	" " " " "	" " "	3438
3516	Excelsior Guano, Red Brand	" " " " "	Dennis C. Crane, Roselle.	3516
3766	" " Gold Brand	" " " " "	J. B. Eckerson, River Vale.	3766
3918	" " Blue Brand	" " " " "	C. M. Housell, New Brunswick.	3918
3769	Ammoniated Bone Superphosphate	" " " " "	J. B. Eckerson, River Vale.	3769
3541	High-Grade Fish Guano and Potash	" " " " "	H. I. Budd, Mount Holly.	3541
3542	Potato Fertilizer	" " " " "	" " " "	3542
3590	Ralston's High-Grade Knickerbocker Phosphate	" " " " "	Franklin Dye, Trenton.	3590
3651	" Knickerbocker Phosphate	" " " " "	J. H. Denise, Freehold.	3651

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3492	Brown & Gilman's Superphosphate, No. 4	......	0.19	1.58	1.77	1.64	8.06	0.42	2.50	10.98	......	8.48	8.00	2.97	2.00	5.73	$23.13	$32.00	3492
3846	Carey's Celebrated Pure Dissolved Bone	......	0.14	0.31	0.45	4.10	......	0.92	0.45	1.37	......	0.92	......	0.44	28.00	25.70	3.67	34.00	3846
3439	Coe's Excelsior Guano	......	1.54	1.94	3.48	3.50	7.49	0.68	1.21	9.38	10.00	8.17	9.00	4.56	3.40	0.57	30.89	44.00	3439
3598	" Alkaline Bone	......	......	0.90	0.90	1.00	7.50	2.22	3.58	13.30	11.00	9.72	9.00	1.70	1.85	0.51	22.60	30.00	3598
3741	" XXV. Am. Bone Superphosphate	......	0.10	1.10	1.20	0.82	6.95	2.16	3.22	12.33	8.00	9.11	7.00	1.87	1.00	0.36	22.69	25.00	3741
3436	" Peach Tree, Fruit and Grape Vine Fert.	.....	0.14	1.33	1.47	1.25	7.23	1.06	2.48	10.77	10.00	8.29	8.00	3.95	5.50	0.64	24.25	30.00	3436
3438	" High-Grade Ammon. Bone Superphos.	......	0.52	1.55	2.07	2.00	8.73	0.78	2.75	12.26	11.00	9.51	9.00	2.05	2.00	0.49	26.18	29.00	3438
3516	" Excelsior Guano, Red Brand	......	0.86	2.55	3.41	3.50	7.37	0.72	1.47	9.56	11.00	8.09	10.00	4.89	6.00	0.62	31.03	45.00	3516
3766	" " " Gold Brand	......	0.79	1.47	2.26	2.50	7.82	0.82	1.75	10.39	9.00	8.64	8.00	4.86	6.00	0.39	28.24	40.00	3766
3918	" " " Blue Brand	1.43	2.37	1.41	5.21	6.50	7.47	1.52	0.39	9.38	8.00	8.99	6.00	2.58	2.50	0.45	34.53	45.00	3918
3769	" Ammoniated Bone Superphosphate	......	0.14	1.14	1.28	1.75	7.77	1.91	3.20	12.88	9.00	9.68	8.00	1.75	1.35	0.38	23.72	30.00	3769
3541	" High-Grade Fish Guano and Potash	......	0.17	3.58	3.75	3.28	0.15	4.18	5.11	9.39	7.00	4.28	6.00	2.21	2.75	5.54	24.66	32.00	3541
3542	" Potato Fertilizer	......	0.62	2.61	3.23	2.05	7.90	1.23	1.74	10.87	9.00	9.13	8.00	3.71	6.00	0.50	30.88	38.00	3542
3590	Ralston's High-Grade Knickerbocker Phos.	......	0.65	1.71	2.36	2.00	8.43	0.96	2.39	11.78	......	9.39	9.00	2.74	1.62	0.45	27.59	33.00	3590
3651	" Knickerbocker Phosphate	......	0.16	1.89	2.05	1.45	7.47	1.20	3.01	11.68	6.00	8.67	......	1.64	2.00	0.67	24.35	28.00	3651

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3723	Ground Bone	E. Frank Coe, New York.	Augustus Dilts, Copper Hill.	3723
3518	Potato, Hop and Tobacco Phosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Dennis C. Crane, Roselle.	3518
3787	Special Potato Manure	" " " " " " "	H. I. Budd, Mount Holly.	3787
3727	Wheat and Corn Phosphate	" " " " " " "	Augustus Dilts, Copper Hill.	3727
3544	New Rival Ammoniated Superphosphate	" " " " " " "	H. I. Budd, Mount Holly.	3544
3770	Ammoniated Bone Superphosphate	" " " " " " "	J. B. Eckerson, River Vale.	3770
3772	Vegetable Bone Superphosphate	" " " " " " "	" " " "	3772
3562	Special Potato Fertilizer	Dambmann Bros. & Co., Baltimore, Md.	J. H. Richardson, Rio Grande.	3562
3674	Arlington "B" Ammoniated Soluble Phosphate	" " " " "	J. J. Mitchell, Whippany.	3674
3675	Special Orange and Peach Tree Fertilizer	" " " " "	" " "	3675
3746	Wheat, Corn and Oats Fertilizer	" " " " "	Dennis C. Crane, Roselle.	3746
3839	Special Grass Manure	" " " " "	D. R. Warbasse, Huntsburgh.	3839
3673	Arlington for Truck	" " " " "	J. J. Mitchell, Whippany.	3673
3563	Pride of New Jersey	" " " " "	J. H. Richardson, Rio Grande.	3563
3476	Potato and Root Crop Manure	Darling Fertilizer Co., Pawtucket, R. I.	J. M. White, New Brunswick.	3476

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	C	V	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3728	Coe's Ground Bone......	......	0.31	2.19	2.50	2.00	0.12	5.34	15.10	20.56	....	5.46	....	0.23	2.75	0.39	$26.50	$34.00	3728
3518	Crocker's Potato, Hop and Tobacco Phos.....	.. ...	0.10	2.06	2.16	2.05	8.16	0.91	1.83	10.90	11.00	9.07	10.00	4.01	3.24	3.95	26.57	40.00	3518
3787	" Special Potato Manure..................	0.78	0.15	3.19	4.12	3.69	5.96	0.84	2.56	9.36	9.00	6.80	8.00	6.14	5.40	6.04	31.57	37.50	3787
3727	" Wheat and Corn Phosphate.........	......	......	2.23	2.23	2.05	8.45	0.79	2.08	11.32	11.00	9.24	10.00	2.24	1.63	2.08	25.63	35.00	3727
3544	" New Rival Am. Superphos............	......	0.15	1.29	1.44	1.23	5.42	1.49	3.94	10.85	11.00	6.91	10.00	2.10	1.60	2.29	20.20	30.00	3544
3770	" Ammoniated Bone Superphos......	......	0.19	2.81	3.00	2.87	6.93	0.55	2.82	10.30	11.00	7.48	10.00	1.35	1.08	1.6	25.08	38.00	3770
3772	" Vegetable Bone Superphosphate...	......	0.11	4.94	5.05	4.92	4.56	1.74	1.57	7.87	7.00	6.30	6.00	7.51	6.00	7.40	34.95	46.00	3772
3562	Dambmann's Special Potato Fertilizer.........	1.15	......	1.38	2.53	2.46	6.03	0.98	2.66	9.67	9.00	7.01	6.00	9.41	9.00	9.60	29.32	40.00	3562
3674	" Arl'ton "B" Am. Sol. Phos.....	0.45	0.35	1.42	2.22	1.85	7.20	1.03	2.45	10.68	....	8.23	9.00	2.79	2.25	3.64	24.48	33.00	3674
3675	" Spec. Orange and Peach Fert..	0.67	0.27	2.37	3.31	2.46	7.95	0.17	0.26	8.38	9.00	8.12	6.00	7.51	9.00	7.73	30.83	42.00	3675
3746	" Wheat, Corn and Oats Fert.....	0.25	......	1.60	1.85	1.64	5.96	1.77	4.65	12.38	10.00	7.73	9.00	1.84	2.00	8.55	22.99	29.00	3746
3839	" Special Grass Manure.............	......	......	2.26	2.26	1.54	8.04	0.75	1.84	10.63	11.00	8.79	9.00	5.21	4.50	5.42	27.53	37.00	3839
3673	" Arlington for Truck	0.64	0.13	2.28	3.05	3.28	8.60	0.96	1.52	11.08	10.00	9.56	9.50	2.45	2.50	2.74	28.47	36.00	3673
3563	" Pride of New Jersey...............	.....	0.15	1.29	1.44	1.23	7.26	0.89	3.12	11.27	....	8.15	9.00	2.58	2.50	6.69	22.13	30.00	3563
3476	Darling's Potato and Root Crop Manure......	......	0.22	2.94	3.16	2.73	2.66	3.58	3.52	9.70	10.00	6.24	....	6.34	7.00	1.78	29.74	40.00	3476

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3522	Wheat and Corn	The Darling Fertilizer Co., Pawtucket, R. I.	Dennis C. Crane, Roselle.	3522
3524	Special Long Island Brand	" " " " " "	" " "	3524
3680	Animal Fertilizer	" " " " " "	J. J. Mitchell, Whippany.	3680
3774	Extra Bone Fertilizer	" " " " " "	J. B. Eckerson, River Vale.	3774
3794	Potato Fertilizer	H. W. Doughten, Moorestown, N. J.	H. I. Budd, Mount Holly.	3794
3795	Dried and Ground Fish	" " " "	" " " "	3795
3809	Esmeralda Fish	Equitable Fertilizer Co., Baltimore, Md.	J. C. Griscom, Woodbury.	3809
3811	" Rose Bone	" " " " "	" " "	3811
3810	" Potato and Tomato	" " " " "	" " "	3810
3564	Fish and Potash	J. C. Fifield & Sons, Bakersville, N. J.	J. H. Richardson, Rio Grande.	3564
3849	Potato Manure	" " " " "	C. Kraus, Egg Harbor City.	3849
3630	Astral Bone	" " " " "	H. I. Budd, Mount Holly.	3630
3631	Truckers' Delight	" " " " "	" " " "	3631
3748	Potato Manure	Geo. B. Forrester, New York.	Dennis C. Crane, Roselle.	3748
3397	Pride of Cumberland	Garrison & Minch, Bridgeton, N. J.	Theo. F. Baker, Bridgeton.	3397

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3522	Darling's Wheat and Corn	......	0.17	2.44	2.61	2.05	5.36	2.98	3.90	12.24	9.00	8.34	....	2.92	2.00	2.86	$27.20	$37.00	3522
3524	" Special Long Island Brand	......	0.22	2.86	3.08	3.69	3.36	6.01	2.27	11.64	10.00	9.37	....	6.18	5.00	6.41	32.41	42.00	3524
3680	" Animal Fertilizer	......	0.12	1.87	1.99	3.28	0.09	7.53	13.69	21.31	10.00	7.62	....	10.08	4.00	10.71	36.24	38.00	3680
3774	" Extra Bone Fertilizer	......	......	2.22	2.22	2.46	5.49	2.39	4.13	12.01	10.00	7.88	7.00	5.47	3.00	5.87	27.54	38.00	3774
3794	Doughten's Potato Fertilizer	1.04	0.59	2.08	3.71	3.28	6.65	1.45	1.35	9.45	8.00	8.10	7.00	8.50	6.00	8.07	33.52	39.00	3794
3795	" Dried and Ground Fish	......	0.42	4.41	4.83	4.10	1.50	4.04	3.53	9.07	....	5.54	6.00	2.86	3.00	3.26	29.97	29.00	3795
3809	Esmeralda Fish	......	0.21	1.16	1.37	1.23	3.87	4.15	4.13	12.15	11.00	8.02	9.00	1.56	1.00	2.32	21.36	*30.00	3809
3811	" Rose Bone	......	......	0.65	0.65	0.30	6.09	2.54	8.00	16.63	11.50	8.63	9.50	1.89	1.00	2.88	22.51	*25.00	3811
3810	" Potato and Tomato	......	0.89	1.31	2.20	2.27	2.54	4.51	5.33	12.38	8.00	7.05	6.00	6.84	7.00	7.31	28.12	40.00	3810
3564	Fifield's Fish and Potash	......	0.39	1.82	2.21	2.46	2.82	1.49	0.96	5.27	7.00	4.31	2.00	3.12	2.00	6.85	17.80	30.00	3564
3849	" Potato Manure	......	......	2.67	2.67	2.46	4.31	2.18	3.10	9.59	7.00	6.49	....	7.75	7.00	7.90	28.31	40.00	3849
3630	" Astral Bone	0.40	0.24	2.49	3.13	2.46	5.00	1.85	3.83	10.68	5.00	6.85	....	3.12	3.00	3.48	26.52	34.00	3630
3681	" Truckers' Delight	......	......	1.14	1.14	0.82	4.86	2.21	2.72	9.79	9.00	7.07	7.00	1.64	1.00	1.92	18.31	25.00	3681
3748	Forrester's Potato Manure	1.00	3.12	1.27	5.39	3.50	7.88	0.20	0.02	8.10	....	8.08	5.25	8.61	10.00	1.78	40.39	42.00	3748
3397	Garrison & Minch's Pride of Cumberland	0.42	......	1.54	1.96	2.05	3.57	1.74	3.21	8.52	10.00	5.31	9.00	3.87	3.00	6.46	20.36	25.00	3397

* In Bulletin 78 the selling prices of these brands were published at $35 and $30, respectively. It has since been learned that they were sold in Gloucester county at an advance of $5 per ton over and above the regular agent's prices.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3398	Bay Side	Garrison & Minch, Bridgeton, N. J.	Theo. F. Baker, Bridgeton.	3398
3399	Peach Grower	" " " " "	" " " "	3399
3400	Trucker's Pride	" " " " "	" " " "	3400
3494	Our Pride Fish Guano	" " " " "	Woodnutt Pettit, Salem.	3494
3545	High-Grade Manure	J. C. Gaskill & Son, Mount Holly, N. J.	H. I. Budd, Mount Holly.	3545
3546	Special Fish Manure	" " " " " " "	" " " "	3546
3749	Union County Fertilizer	Theodore Glaser, Linden, N. J.	Dennis C. Crane, Roselle.	3749
3445	Vegetable and Potato	Great Eastern Fertilizer Co., Rutland, Vermont.	J. H. Denise, Freehold.	3445
3728	Great Eastern General	" " " " " "	Augustus Dilts, Copper Hill.	3728
3777	Metropolitan	H. B. Griffin, New York.	J. B. Eckerson, River Vale.	3777
3884	Garden and Truck High Grade	D. D. Hess & Son, Reading, Pa.	T. M. Boyer, Bridgeville.	3884
3729	Index Bone Phosphate	The Index Co., Limited, Philadelphia, Pa.	Augustus Dilts, Copper Hill.	3729
3497	Farmer's Bone Phosphate	Lewis & Price, Smyrna, Del.	Woodnutt Pettit, Salem.	3497
3498	Special Truck Phosphate	" " " " "	" " "	3498
3499	" Phosphate for Potatoes	" " " " "	" " "	3499

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3398	Garrison & Minch's Bay Side	......	0.18	1.02	1.20	2.05	4.22	2.48	1.78	8.48	7.50	6.70	....	2.88	2.50	7.40	$18.46	$24.00	3398
3399	" " Peach Grower	... ..	......	0.67	0.67	0.82	3.15	2.01	6.16	11.35	8.00	5.19	....	7.24	10.00	12.00	20.80	23.00	3399
3400	" " Trucker's Pride	1.40	1.02	1.82	4.24	5.33	6.14	1.18	1.88	8.60	....	7.27	9.50	5.10	4.00	0.64	32.02	36.00	3400
3494	" " Our Pride Fish Guano	0.33	0.45	2.25	3.03	4.10	4.05	2.27	1.41	7.73	6.00	6.32	....	7.40	8.00	9.66	27.76	36.00	3494
3515	Gaskill's High-Grade Manure	0.30	0.87	2.13	3.30	3.28	6.30	0.98	2.21	9.49	8.00	7.28	6.00	6.10	6.00	5.57	29.54	42.00	3515
3546	" Special Fish Manure	......	......	2.68	2.68	2.46	6.24	1.40	4.51	12.15	8.00	7.64	6.00	4.42	4.00	5.09	28.02	32.00	3546
3749	Glaser's Union County Fertilizer	......	0.76	1.33	2.09	2.46	1.53	1.97	0.38	3.88	4.00	3.50	....	2.81	3.00	4.57	15.46	25.00	3749
3445	Great Eastern Vegetable and Potato	......	......	2.17	2.17	2.05	6.75	1.20	2.16	10.11	9.00	7.95	8.00	3.43	4.00	5.37	24.49	33.00	3445
3728	Great Eastern General	......	......	2.49	2.49	2.23	6.35	1.43	2.45	10.23	12.14	7.78	11.52	2.00	2.13	8.03	24.19	33.00	3728
3777	Griffin's Metropolitan	......	0.32	1.03	1.35	0.82	4.55	1.22	1.92	7.69	3.50	5.77	....	1.79	1.00	4.89	16.58	27.50	3777
3884	Hess' Garden and Truck	0.74	1.03	1.39	3.16	3.28	8.40	0.54	1.47	10.41	....	8.94	10.00	4.34	2.70	4.57	29.47	40.00	3884
3729	Index Bone Phosphate	......	0.11	3.96	4.07	3.28	0.20	9.83	1.91	11.94	11.00	10.03	6.00	0.33	....	0.28	31.33	26.00	3729
3497	Lewis & Price's Farmer's Bone	......	......	1.83	1.83	1.64	5.04	2.43	2.62	10.09	10.00	7.47	7.00	3.47	3.00	7.91	22.86	28.00	3497
3498	" " Special Truck Phosphate	......	0.10	2.26	2.36	2.46	5.31	2.78	2.07	10.16	10.00	8.09	....	4.64	4.00	7.96	26.39	30.00	3498
3499	" " " Phos. for Potatoes	......	0.13	2.80	2.93	3.28	5.98	2.28	1.86	10.02	9.00	8.16	....	7.12	6.00	8.48	30.55	38.00	3499

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3526	Potato Fertilizer, No. 1	Lister's A. C. Works, Newark, N. J.	Dennis C. Crane, Roselle.	3526
3586	U. S. Phosphate	" " " " "	Franklin Dye, Trenton.	3586
3694	Ammoniated Dissolved Bone	" " " " "	I. W. Nicholson, Camden.	3694
3781	Harvest Queen Fertilizer	" " " " "	Augustus Dilts, Copper Hill.	3781
3843	Success Fertilizer	" " " " "	J. M. White, New Brunswick.	3843
3908	Corn Fertilizer, No. 1	" " " " "	J. J. Mitchell, Whippany.	3908
3479	Standard Superphosphate of Lime	" " " " "	J. H. Denise, Freehold.	3479
3500	Potato Fertilizer, No. 2	" " " " "	Woodnutt Pettit, Salem.	3500
3566	Turnip and Spinach Fertilizer	" " " " "	J. H. Richardson, Rio Grande.	3566
3567	Champion Phosphate	Lord & Polk Chemical Co., Odessa, Del.	" " " "	3567
3568	Truxillo Guano	" " " " " "	" " " "	3568
3402	Tobacco Manure, Wrapper Brand	Mapes' F. & P. Guano Co., New York.	Theo. F. Baker, Bridgeton.	3402
3601	Potato Manure	" " " " "	J. V. D. Pumyea, Plainville.	3601
3403	Complete Manure, "A" Brand	" " " " "	Theo. F. Baker, Bridgeton.	3403
3684	" " for general use	" " " " "	H. I. Budd, Mount Holly.	3684

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3526	Lister's Potato Fertilizer, No. 1	0.57	0.92	2.54	4.03	3.69	6.35	2.02	0.44	8.81	....	8.37	8.50	6.72	7.00	4.80	$33.24	$40.00	3526
3586	" U. S. Phosphate	......	0.34	1.42	1.76	1.31	4.34	2.36	2.60	9.80	7.00	7.20	6.00	2.12	2.00	1.09	21.19	25.00	3586
3694	" Ammoniated Dissolved Bone	......	0.42	1.80	2.22	1.80	6.44	3.71	1.58	11.73	11.00	10.15	9.00	1.63	1.50	1.04	26.29	33.00	3694
3731	" Harvest Queen Fertilizer	......	0.40	1.73	2.13	1.03	7.16	2.51	2.05	11.72	....	9.67	10.50	1.38	1.50	0.45	25.43	25.00	3731
3843	" Success Fertilizer	......	0.30	1.39	1.69	1.02	8.70	2.39	0.95	12.04	....	11.09	10.50	1.74	1.50	0.37	26.00	27.00	3843
3908	" Corn Fertilizer, No. 1	0.34	1.21	2.71	4.26	3.69	7.29	1.00	0.50	8.79	....	8.29	9.00	6.98	7.00	4.21	34.61	40.00	3908
3479	" Standard Superphosphate	......	0.42	2.33	2.75	2.34	6.98	2.56	2.16	11.65	12.00	9.49	10.00	1.86	1.50	1.63	27.51	34.00	3479
3500	" Potato Fertilizer, No. 2	......	0.28	2.35	2.63	1.80	6.14	4.42	2.86	13.42	....	10.56	9.25	4.03	4.00	3.87	31.18	34.00	3500
3566	" Turnip and Spinach Fertilizer	......	1.66	2.33	3.99	5.74	7.66	2.04	0.64	10.34	....	9.70	7.25	6.33	3.25	6.00	35.16	36.00	3566
3567	Lord & Polk's Champion Phosphate	0.32	0.10	0.73	1.15	1.23	6.41	1.30	3.97	11.68	9.00	7.71	7.00	3.24	2.00	3.47	21.39	27.00	3567
3568	" " Truxillo Guano	1.75	0.17	0.86	2.78	2.46	4.68	2.65	4.20	11.53	....	7.33	9.00	4.53	5.00	4.76	26.91	33.00	3568
3402	Mapes' Tobacco Manure, Wrapper Brand	1.33	3.62	1.64	6.59	6.15	1.11	2.74	1.72	5.57	4.50	3.85	....	11.28	10.50	1.41	41.91	55.00	3402
3601	" Potato Manure	1.53	0.89	1.67	4.09	3.69	2.94	5.29	3.37	11.60	8.00	8.23	....	7.05	6.00	0.68	36.52	45.00	3601
3408	" Complete Manure, "A" Brand	0.68	0.56	1.81	3.05	2.46	3.24	6.77	4.01	14.02	12.00	10.01	10.00	3.32	2.50	2.66	31.43	35.00	3408
3634	" " " for general use	0.84	1.01	2.18	4.03	3.23	6.78	3.02	2.07	11.87	10.00	9.80	8.00	4.12	4.00	3.82	33.91	41.00	3634

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3417	Grass and Grain Spring Top Dressing	Mapes' F. & P. Guano Co., New York.	J. H. Denise, Freehold.	3417
3456	Ammoniated Dissolved Bone with Potash	" " " " "	Franklin Dye, Trenton.	3456
3633	Lobos Guano	" " " " "	H. I. Budd, Mount Holly.	3633
3697	Fish Guano	" " " " "	I. W. Nicholson, Camden.	3697
3792	Cabbage and Cauliflower Manure	" " " " "	H. I. Budd, Mount Holly.	3792
3818	Complete Manure for Light Soils	" " " " "	J. C. Griscom, Woodbury.	3818
3853	Fruit and Vine Manure	" " " " "	Charles Kraus, Egg Harbor City.	3853
3854	Peach Tree Manure	" " " " "	" " " " "	3854
3911	Corn Manure	" " " " "	J. J. Mitchell, Whippany.	3911
3752	Acme Fertilizer, No. 2	C. Meyer, Jr., Maspeth, L. I.	Dennis C. Crane, Roselle.	3752
3753	" " "E" Brand	" " " " "	" " " "	3753
3754	" Potato Fertilizer	" " " " "	" " " "	3754
3755	" Fertilizer, No. 1	" " " " "	" " " "	3755
3686	Standard Superphosphate of Lime	H. S. Miller & Co., Newark, N. J.	J. J. Mitchell, Whippany.	3686
3463	Harvest Queen	" " " " "	Franklin Dye, Trenton.	3463

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3147	Mapes' Grass and Grain Top Dressing	0.68	1.44	2.24	4.36	4.10	5.90	2.70	2.88	10.98	7.00	8.60	....	5.22	5.00	5.10	$34.38	$42.00	3147
3456	" Ammon. Diss. Bone with Potash	......	......	1.61	1.61	1.23	7.56	3.56	2.62	13.74	12.00	11.12	10.00	2.13	1.50	3.52	26.76	29.00	3456
3633	Lobos Guano	......	1.99	1.04	3.03	......	3.86	5.87	10.86	20.09	....	9.73	....	3.51	....	2.21	35.44	*	3633
3697	Mapes' Fish Guano	......	0.21	4.50	4.71	4.10	0.54	3.40	7.05	10.99	6.00	3.94	....	3.84	3.00	3.80	30.00	36.00	3697
3792	" Cabbage and Cauliflower	1.01	1.09	2.43	4.56	4.51	3.58	3.80	2.52	9.85	6.00	7.33	....	9.27	8.00	8.44	36.58	45.00	3792
3818	" Complete Manure for Light Soils	0.71	1.92	2.33	4.96	4.92	3.36	4.84	1.48	9.68	8.00	8.20	6.00	6.53	6.00	5.45	36.40	46.00	3818
3853	" Fruit and Vine Manure	0.63	0.50	1.90	3.03	1.64	7.50	0.75	0.10	8.35	7.00	8.25	....	11.20	11.00	0.66	36.43	40.00	3853
3854	" Peach Tree Manure	0.40	0.61	1.69	2.70	1.64	5.41	3.43	0.78	9.62	8.00	8.84	....	9.16	8.00	4.11	32.97	36.00	3854
3911	" Corn Manure	1.26	0.78	2.03	4.07	3.69	8.70	1.98	1.70	12.38	10.00	10.68	8.00	5.23	6.00	4.94	36.02	43.00	3911
3752	Meyer's Acme Fertilizer, No. 2	......	2.33	2.17	4.50	4.92	3.32	4.82	2.45	10.09	....	7.64	8.00	5.37	5.00	4.00	33.82	43.00	3752
3753	" " " "E" Brand	......	0.78	2.30	3.08	2.46	3.41	7.17	3.09	13.70	....	10.61	10.00	2.72	3.78	1.49	31.96	35.00	3753
3754	" " Potato Fertilizer	......	1.28	1.46	2.74	2.46	3.99	3.29	1.83	9.11	....	7.28	7.00	6.81	9.00	1.90	29.47	38.00	3754
3755	" " Fertilizer, No. 1	......	1.67	2.26	3.93	3.69	3.00	4.69	1.58	9.27	....	7.69	8.00	6.87	9.00	3.60	33.43	43.00	3755
3686	Miller's Standard Superphosphates	......	0.14	2.74	2.88	2.34	8.22	3.99	1.32	13.53	11.50	12.21	10.00	2.73	1.50	0.41	33.24	34.00	3686
3463	" Harvest Queen	......	0.11	1.74	1.85	1.03	10.29	0.20	0.87	10.86	12.50	10.49	10.00	2.45	1.50	0.32	26.10	26.00	3463

*The Mapes F. & P. Guano Co. are headquarters for Lobos guano. Their retail price for one bag and upward is $40 per ton; for three tons and upward, $38 per ton. Sample 3633 was reported to us as Peruvian guano No. 1, selling price $32 per ton, and was so published in Bulletin 73.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3459	Chanticleer Fertilizer	H. S. Miller & Co., Newark, N. J.	Franklin Dye, Trenton.	3459
3685	Ammoniated Dissolved Bone Phosphate	" " " " "	J. J. Mitchell, Whippany.	3685
3757	Corn and Potato Phosphate	" " " " "	Dennis C. Crane, Roselle.	3757
3654	Vegetable Fertilizer	" " " " "	J. H. Denise, Freehold.	3654
3915	Buffalo Guano	Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	J. J. Mitchell, Whippany.	3915
3914	Potato, Hop and Tobacco Phosphate	" " " " " " "	" " "	3914
3916	Buffalo Fertilizer	" " " " " " "	" " "	3916
3656	Tomato Manure	A. Mitchell, Tremley, N. J.	J. H. Denise, Freehold.	3656
3655	Potato Manure	" " " "	" " "	3655
3449	Truck Fertilizer	Monmouth Fertilizer Co., Asbury Park, N. J.	" " "	3449
3589	Monmouth Potato Fertilizer	" " " " " "	Franklin Dye, Trenton.	3589
3890	All-Crop Fertilizer	" " " " " "	J. H. Denise, Freehold.	3890
3657	Chittenden's Complete Fertilizer	National Fertilizer Co., Bridgeport, Conn.	" " "	3657
3451	Special Potato Manure	J. E. & A. Nelson, Imlaystown, N. J.	" " "	3451
3452	Complete Manure for Grass	" " " " "	" " "	3452

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3459	Miller's Chanticleer Fertilizer	......	0.31	0.94	1.25	0.82	5.71	1.52	3.18	10.41	7.00	7.23	6.00	2.27	2.50	0.42	$20.29	$24.00	3459
3685	" Ammon. Dissolved Bone Phosphate,	......	0.14	1.86	2.00	1.84	9.20	0.52	0.22	9.94	10.50	9.72	9.00	2.61	1.50	0.41	25.45	30.00	3685
3757	" Corn and Potato Phosphate	......	......	2.02	2.02	1.23	7.62	1.16	0.53	9.31	7.50	8.78	6.50	4.10	3.00	0.42	26.00	30.00	3757
3654	" Vegetable Fertilizer	......	3.83	0.65	4.48	3.69	7.87	0.56	0.08	8.51	....	8.43	8.50	6.47	7.00	5.98	34.59	40.00	3654
3915	Milsom's Buffalo Guano	......	0.20	1.18	1.38	1.64	2.30	2.47	6.27	11.04	10.00	4.77	7.00	0.93	1.00	0.82	17.07	32.00	3915
3914	" Potato, Hop and Tobacco	......	0.23	2.88	3.11	2.46	5.91	0.60	3.87	10.38	11.00	6.51	8.00	3.56	1.65	3.69	26.47	35.00	3914
3916	" Buffalo Fertilizer	......	0.15	2.93	3.08	2.46	6.38	0.42	3.37	10.17	10.00	6.80	8.00	0.85	1.50	0.82	24.14	33.00	3916
3656	Mitchell's Tomato Manure	0.59	0.92	1.40	2.91	2.87	7.50	0.84	2.18	10.52	6.00	8.34	....	6.17	5.50	0.33	31.53	45.00	3656
3655	" Potato Manure	0.60	1.68	0.66	2.94	3.69	7.58	1.38	1.13	10.09	....	8.96	9.00	6.32	9.00	5.45	30.40	45.00	3655
3449	Monmouth Truck Fertilizer	0.16	0.60	2.07	2.83	2.05	0.20	4.68	8.25	13.13	6.50	4.88	3.75	2.16	2.90	2.13	24.24	30.00	3449
3589	" Potato Fertilizer	......	1.78	1.39	3.17	2.73	0.08	1.68	3.89	5.65	10.00	1.76	....	3.39	10.00	3.09	23.48	35.00	3589
3890	" All-Crop Fertilizer	......	1.60	1.33	2.93	2.66	0.35	3.34	6.11	9.80	9.00	3.69	....	4.00	4.00	4.12	23.13	30.00	3890
3657	Chittenden's Complete Fertilizer	0.78	0.13	2.93	3.84	3.28	2.40	4.31	7.55	14.26	8.00	6.71	6.00	6.03	6.00	0.33	34.87	42.00	3657
3451	Nelson's Special Potato Manure	......	0.13	1.83	1.96	2.05	5.91	1.50	2.86	10.27	8.00	7.41	....	5.56	6.00	6.94	25.24	35.00	3451
3452	" Complete Manure for Grass	0.15	0.15	1.60	1.90	2.05	6.48	1.33	3.37	11.18	8.00	7.81	....	2.24	2.00	3.60	22.93	30.00	3452

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3483	Victor Bone Potato Fertilizer	New Jersey Chemical Co., Philadelphia, Pa.	J H. Denise, Freehold.	3483
3484	Lolland's Button-Bone Fertilizer	" " " " " "	" " "	3484
3485	Arroo Guano	" " " " " "	" " "	3485
3639	Victor Ammoniated Bone Fertilizer	" " " " " "	H. I. Budd, Mount Holly.	3639
3793	Dried and Ground Fish	James E. Otis, Tuckerton, N. J.	" " " "	3793
3859	Menhaden Guano	" " " " "	C. Kraus, Egg Harbor City.	3859
3759	Pacific Guano Special Potato	Pacific Guano Co., Boston, Mass.	Dennis C. Crane, Roselle.	3759
3821	Potato Manure	Albert Parker, Mullica Hill, N. J.	Jas. C. Griscom, Woodbury.	3821
3501	Moro Phillips' Genuine Impr. Superphosphate	Frederick Phillips, Philadelphia, Pa.	Woodnutt Pettit, Salem.	3501
3610	Moro Phillips' Pure Phuine	" " " "	H. I. Budd, Mount Holly.	3640
3688	Potato Fertilizer	H. Preston & Sons, Greenpoint, L. I.	J. J. Mitchell, Whippany.	3688
3689	Lawn Dressing	" " " " "	" " "	3689
3690	Corn Fertilizer	" " " " "	" " "	3690
3692	Ground Bone	" " " " "	" " "	3692
3687	Ammoniated Bone Superphosphate	" " " " "	" " "	3687

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. I	Nitrogen. I	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3483	Victor Bone Potato Fertilizer	......	0.11	1.58	1.64	1.44	4.49	1.81	2.63	8.43	9.00	5.80	7.20	4.84	5.00	7.28	$20.79	$33.00	3483
3484	Lofland's Button-Bone Fertilizer	......	1.14	0.51	1.65	1.23	5.18	2.17	8.96	11.31	....	7.35	10.00	2.42	2.50	3.88	21.93	26.00	3484
3485	Arroo Guano	......	1.84	2.01	3.85	4.51	6.35	0.60	1.86	8.81	....	6.95	8.00	7.44	6.00	7.21	32.03	48.00	3485
3639	Victor Ammoniated Bone Fertilizer.	......	......	1.33	1.33	1.23	3.80	2.38	2.78	8.96	....	6.18	6.00	2.12	2.50	4.65	17.99	25.00	3639
3798	Otis' Dried and Ground Fish	......	0.48	3.54	4.02	3.28	2.22	2.56	2.45	7.23	9.00	4.78	....	3.81	5.00	7.68	26.22	31.00	3798
3859	" Menhaden Guano	......	0.40	4.00	4.40	3.28	2.84	3.06	1.97	7.87	9.00	5.90	....	3.11	3.00	6.82	28.38	29.00	3859
3759	Pacific Guano Special Potato	......	......	0.52	0.52	3.50	8.16	4.56	3.64	16.36	9.00	12.72	6.00	0.36	7.00	0.62	24.63	35.00	3759
3821	Parker's Potato Manure	0.76	0.63	1.59	2.98	2.46	4.86	1.74	4.29	10.89	11.00	6.60	....	3.86	6.00	8.65	30.86	33.00	3821
3501	Phillips' Genuine Improved Superphos.	......	0.11	1.99	2.10	1.64	7.20	1.18	2.74	11.12	12.00	8.38	10.00	2.58	2.00	0.83	24.96	30.00	3501
3640	Moro Phillips' Pure Phuine.	0.23	0.26	0.96	1.45	1.23	7.04	2.45	4.24	13.73	9.00	9.49	....	1.38	1.00	2.18	23.77	38.00	3640
3688	Preston's Potato Fertilizer	......	0.60	2.12	2.72	3.28	4.95	2.08	1.29	8.32	....	7.03	8.00	7.43	7.00	2.53	29.69	40.00	3688
3689	" Lawn Dressing	......	1.09	2.28	3.37	2.46	4.95	3.94	2.59	11.48	....	8.89	6.00	2.07	3.00	0.84	29.38	45.00	3689
3690	" Corn Fertilizer	......	1.02	2.03	3.05	4.10	3.51	4.24	3.19	10.94	....	7.75	9.00	2.20	6.00	0.53	27.11	40.00	3690
3692	" Ground Bone	......	0.43	2.95	3.38	4.25	0.83	5.85	6.29	12.97	9.77	6.68	....	0.65	3.43	2.33	26.54	32.00	3692
3687	" Ammoniated Bone Superphos.	......	0.48	1.96	2.44	2.46	3.84	4.09	3.14	11.07	....	7.93	9.00	2.74	2.00	0.65	25.88	35.00	3687

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3502	Provident Tried and True Phosphate	The Provident F. & P. Co., Philadelphia, Pa.	Woodnutt Pettit, Salem.	3502
3530	Quaker City Poudrette	Quaker City Odorless Excavating Co., Philadelphia, Pa.	Dennis C. Crane, Roselle.	3530
3610	Lion Brand	Read Fertilizer Co., Syracuse, N. Y.	Franklin Dye, Trenton.	3610
3609	High-Grade Farmer's Friend	" " " " "	" " "	3609
3611	Leader Brand	" " " " "	" " "	3611
3721	King Phillip	John S. Reese & Co., New Bedford, Mass.	Augustus Dilts, Copper Hill.	3721
3740	Great Planet Manure, Formula "B"	" " " " " "	Dennis C. Crane, Roselle.	3740
3750	" " " Formula "A"	" " " " " "	" " " "	3750
3720	Unicorn	" " " " " "	Augustus Dilts, Copper Hill.	3720
3550	Standard Fertilizer	Shanley & Van Brunt, Philadelphia, Pa.	H. I. Budd, Mount Holly.	3550
3663	" Potato Grower	" " " " "	J. H. Denise, Freehold.	3663
3824	" Slaughter-House	" " " " "	J. C. Griscom, Woodbury.	3824
3421	Dissolved Bone Phosphate	Sharpless & Carpenter, Philadelphia, Pa.	George A. MacBean, Lakewood.	3421
3642	Fish Guano	" " " "	H. I. Budd, Mount Holly.	3642

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3502	Provident Tried and True	......	......	1.41	1.41	1.64	4.14	2.69	3.65	10.48	10.00	6.83	7.00	2.49	2.00	6.17	$20.14	$30.00	3502
3530	Quaker City Poudrette	......	0.34	1.04	1.38	1.23	0.47	2.54	0.51	3.52	4.00	3.01	....	0.26	1.00	0.48	10.05	23.00	3530
3610	Read's Lion Brand	......	0.11	0.97	1.08	0.82	6.38	1.24	1.95	9.57	10.00	7.62	8.00	4.09	4.30	4.56	20.71	29.00	3610
3609	" High-Grade Farmer's Friend	......	0.15	3.15	3.30	3.28	3.24	1.09	2.13	6.46	6.00	4.33	5.00	9.14	5.40	3.46	27.65	38.00	3609
3611	" Leader Brand	0.10	0.10	0.90	1.10	0.82	4.94	1.38	2.70	9.02	8.00	6.32	7.00	2.25	2.16	3.60	17.45	25.00	3611
3721	Reese's King Phillip	......	0.18	1.72	1.90	1.23	5.65	0.91	2.91	9.47	....	6.56	6.50	3.74	3.00	3.71	22.08	28.00	3721
3740	" Great Planet, "B"	2.60	0.98	0.98	4.56	4.92	4.38	1.28	1.41	7.07	....	5.66	5.00	7.23	7.00	2.08	31.97	40.00	3740
3750	" " " "A"	1.23	0.12	2.07	3.42	3.28	3.87	2.74	4.52	11.13	....	6.61	7.00	9.97	9.50	10.20	33.27	39.00	3750
3720	" Unicorn	......	0.25	2.34	2.59	1.85	7.16	0.73	3.93	11.82	....	7.89	8.50	2.75	2.25	3.13	26.28	33.00	3720
3550	Shanley & Van Brunt's Standard	......	0.28	1.57	1.85	2.46	2.91	1.74	6.35	11.00	9.00	4.65	....	2.32	2.00	2.28	19.63	34.00	3550
3663	" " " " Potato	......	1.40	1.39	2.79	3.28	1.71	1.77	6.60	10.08	6.00	3.48	....	5.70	8.00	5.08	24.15	40.00	3663
3824	" " " Slaughter-House	......	0.32	1.34	1.66	1.64	1.88	1.87	6.00	9.75	7.00	3.75	....	2.28	2.00	2.28	17.30	28.00	3824
3421	Sharpless & Carpenter's Dis. Bone Phos	......	......	1.55	1.55	1.64	4.11	2.40	4.89	11.40	....	6.51	8.00	2.09	2.00	3.77	20.50	33.00	3121
3642	" " Fish Guano	......	0.15	2.53	2.68	2.46	5.18	1.76	5.66	12.60	....	6.94	8.00	3.14	3.00	3.19	26.45	35.00	3642

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3407	Bone Phosphate, No. 1	Sharpless & Carpenter, Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3407
3569	Tampico Guano	" " " " "	J. H. Richardson, Rio Grande.	3569
3553	Swift Sure Superphosphate	M. L. Shoemaker & Co., Philadelphia, Pa.	H. I. Budd, Mount Holly.	3553
3787	Standard for Wheat and Rye	John I. Smith, Trenton, N. J.	August Dilts, Copper Hill.	3787
3591	Potato Fertilizer	" " " "	Franklin Dye, Trenton.	3591
3647	" Grower	Stearns Fertilizer Co., New York.	H. I. Budd, Mount Holly.	3647
3887	Blood Guano	" " " "	T. M. Boyer, Bridgeville.	3887
3888	Sure Growth	" " " "	" " "	3888
3782	Standard Ammoniated Bone Superphosphate	" " " "	J. B. Eckerson, River Vale.	3782
3758	Americo Guano	" " " "	Dennis C. Crane, Roselle.	3758
3505	Extra Potato Special	Stratman & Co., Pittsburg, Pa.	Woodnutt Pettit, Salem.	3505
3699	Peruvian Guano, No. 1	Taylor Bros., Camden. N. J.	I. W. Nicholson, Camden.	3699
3700	Lobos Guano	" " " "	" " "	3700
3613	Complete Fertilizer for Wheat, Oats and Grass	The Taylor Provision Co., Trenton, N. J.	Franklin Dye, Trenton.	3613

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3407	Sharpless & Carpenter's Bone Phos., No. 1...	......	0.11	1.46	1.57	1.23	4.11	2.80	3.55	10.46	....	6.91	8.00	2.13	2.00	3.55	$20.44	$24.00	3407
3569	" " " Tampico Guano......	.. ...	1.09	1.74	2.83	2.87	7.05	1.22	2.96	11.23	....	8.27	9.00	7.46	5.50	7.34	31.35	39.00	3569
3553	Shoemaker's Swift Sure Superphosphate......	0.58	......	2.37	2.95	2.46	7.47	2.02	5.50	14.99	14.00	9.49	9.00	4.49	2.16	4.72	32.26	33.00	3553
3737	Smith's Standard for Wheat........................	0.41	......	2.00	2.41	2.05	9.69	2.41	0.41	12.51	11.00	12.10	10.00	2.88	2.50	4.99	30.19	33.00	3737
3591	" Potato Fertilizer	0.71	0.15	1.96	2.82	2.46	8.40	3.04	0.94	12.38	10.00	11.44	9.00	7.22	10.00	6.99	34.59	40.00	3591
3647	Stearns' Potato Grower................................	......	0.70	1.46	2.16	2.46	3.00	2.77	3.25	9.02	5.00	5.77	....	6.73	5.00	0.64	26.35	44.00	3647
3887	" Blood Guano	......	0.39	1.01	1.40	1.02	2.63	2.05	3.41	8.09	8.00	4.68	7.00	2.30	1.35	4.65	16.37	30.00	3887
3888	" Sure Growth......	......	0.39	0.92	1.31	0.61	2.64	1.69	3.65	7.98	7.00	4.33	6.00	2.34	0.54	4.58	15.72	25.00	3888
3782	" Standard Ammoniated Bone Super.	......	0.41	1.63	2.04	1.64	3.11	4.75	1.73	9.59	8.50	7.86	....	3.34	2.50	1.02	24.16	34.00	3782
3758	" Americo Guano................................	......	0.81	2.87	3.68	4.10	0.90	5.49	3.08	9.47	9.00	6.39	....	7.97	6.00	8.15	31.75	42.50	3758
3505	Stratman's Extra Potato Special...............	......	1.22	2.00	3.22	3.28	1.35	3.58	2.04	6.97	9.00	4.93	8.00	9.88	7.00	9.86	28.95	45.00	3505
3699	Taylor Bros.' Peruvian Guano, No. 1............	0.17	3.42	1.80	5.39	....	5.61	5.67	2.15	13.43	....	11.28	....	2.82	....	4.87	40.12	59.00	3699
3700	" " Lobos Guano..............................	......	2.03	1.41	3.44	....	2.87	5.48	14.86	23.21	....	8.35	....	3.90	....	2.05	37.84	43.00	3700
3613	Taylor's Complete Fertilizer for Wheat, &c..	0.90	......	2.26	3.16	2.46	9.69	2.20	0.98	12.87	10.00	11.89	....	3.37	2.50	3.25	32.93	33.00	3613

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3619	High-Grade Corn and Truck Manure	The Taylor Provision Co., Trenton, N. J.	Franklin Dye, Trenton.	3619
3797	Special Potato Fertilizer	" " " " " "	H. I. Budd, Mount Holly.	3797
3614	High-Grade Fertilizer for Potatoes and Truck	" " " " " "	Franklin Dye, Trenton.	3614
3615	Pure Dissolved Bone	" " " " " "	" " "	3615
3620	Ammoniated Dissolved Bone and Potash	" " " " " "	" " "	3620
3507	Tomato and Potato Manure	I. P. Thomas & Sons Co., Philadelphia, Pa.	Woodnutt Pettit, Salem.	3507
3558	Peach Tree Fertilizer	" " " " " "	H. I. Budd, Mount Holly.	3558
3570	Normal Bone Phosphate	" " " " " "	J. H. Richardson, Rio Grande.	3570
3592	Potato Manure	" " " " " "	Franklin Dye, Trenton.	3592
3704	Fish Guano	" " " " " "	I. W. Nicholson, Camden.	3704
3800	Truck Guano	" " " " " "	H. I. Budd, Mount Holly.	3800
3556	Tip Top Raw Bone Superphosphate	" " " " " "	" " " "	3556
3707	Farmer's Choice Bone Phosphate	" " " " " "	I. W. Nicholson, Camden.	3707
3411	Star Guano	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3411

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
		From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3619	Taylor's High-Grade Corn and Truck	1.07	0.11	1.54	2.72	2.46	4.19	6.49	0.68	11.36	....	10.68	10.00	5.41	5.00	3.30	$31.38	$34.00	3619
3797	" Special Potato Fertilizer	0.75	......	1.40	2.15	2.05	7.07	2.81	0.61	10.49	....	9.88	8.00	9.09	10.00	11.50	31.30	37.00	3797
3614	" High-Grade Fert. for Potatoes	0.78	......	2.02	2.80	2.87	8.12	2.69	0.45	11.26	12.00	10.81	10.00	10.50	10.00	4.49	37.51	42.00	3614
3615	" Pure Dissolved Bone	0.70	......	1.71	2.41	1.64	9.27	2.07	0.54	11.88	9.00	11.34	....	2.70	3.00	4.16	28.73	30.00	3615
3620	" Am. Dissolved Bone and Potash	......	......	1.64	1.64	1.23	2.67	4.68	2.63	9.98	8.00	7.35	....	2.35	2.50	2.58	21.04	25.00	3620
3507	Thomas' Tomato and Potato	0.88	......	0.94	1.32	1.23	2.43	5.34	2.14	9.91	10.50	7.77	9.00	7.41	6.00	4.23	25.24	32.00	3507
3558	" Peach Tree Fertilizer	0.52	......	0.79	1.31	1.02	2.22	5.39	2.62	10.23	10.50	7.61	9.00	8.12	6.00	4.42	25.94	31.00	3558
3570	" Normal Bone Phosphate	......	0.14	1.09	1.23	1.02	4.35	2.49	3.32	10.16	10.50	6.84	8.50	1.97	1.50	2.11	18.39	25.00	3570
3592	" Potato Manure	0.93	0.11	1.63	2.67	2.46	7.83	0.98	1.28	10.09	11.00	8.81	9.00	6.32	6.00	6.25	29.17	38.00	3592
3704	" Fish Guano	......	......	1.38	1.38	1.23	7.51	1.65	2.53	11.69	11.00	9.16	9.00	1.80	2.00	3.74	22.49	30.00	3704
3800	" Truck Guano	......	0.20	1.19	1.39	0.82	4.34	2.73	3.20	10.27	9.00	7.07	7.00	2.07	1.50	2.11	19.82	21.00	3800
3556	" Tip Top Raw Bone Superphosphate	0.90	0.16	2.16	3.22	2.46	7.91	1.73	1.86	11.50	13.00	9.64	10.00	2.60	2.75	2.83	29.38	35.00	3556
3707	" Farmer's Choice Bone	......	......	1.20	1.20	1.44	8.10	1.35	2.72	12.17	11.50	9.45	9.50	1.61	2.00	3.62	22.28	30.00	3707
3411	Tygert-Allen Star Guano	0.79	0.20	1.64	2.63	2.26	5.00	2.76	1.69	9.45	9.50	7.76	7.50	3.76	3.50	3.96	25.36	25.00	3411

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3412	Star Bone Phosphate	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3412
3506	Trucker's Triumph Potato Guano	" " " " " "	Woodnutt Pettit, Salem.	3506
3808	Fish, Bone and Potash	" " " " " "	H. I. Budd, Mount Holly.	3808
3804	Dried and Ground Fish Guano	" " " " " "	" " " "	3804
3572	Blood Phosphate	Wando Phosphate Co., Charleston, S. C.	J. H. Richardson, Rio Grande.	3572
3638	Market Garden Phosphate	Waring Manufacturing Co., Baltimore, Md.	H. I. Budd, Mount Holly.	3638
3510	Fish Ammoniated Superphosphate	" " " " "	Woodnutt Pettit, Salem.	3510
3865	Potato Fertilizer	J. Wenderoth & Sons, Camden, N. J.	Charles Kraus, Egg Harbor City.	3865
3716	Favorite Fertilizer	" " " "	I. W. Nicholson, Camden.	3716
3596	Economical Bone Fertilizer	Wilkinson & Co., New York.	Franklin Dye, Trenton.	3596
3512	Potato Phosphate	Williamson & Clark Fertilizer Co., New York.	Woodnutt Pettit, Salem.	3512
3605	Popular Royal Bone Phosphate	" " " " " "	Franklin Dye, Trenton.	3605
3606	Americus High-Grade Special for Potatoes	" " " " " "	" " "	3606
3866	" Ammoniated Bone Superphosphate	" " " " " "	Charles Kraus, Egg Harbor City.	3866

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Station Number.		Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3412	Tygert-Allen Star Bone Phosphate...............	......	0.18	1.70	1.88	2.05	5.58	1.80	2.42	9.80	8.00	7.38	....	2.55	2.50	4.49	$21.95	$25.00	3412
3506	" " Trucker's Triumph..................	0.81	1.47	1.03	3.31	3.28	4.41	2.38	1.50	8.24	....	6.74	7.00	9.25	8.00	9.40	30.87	38.00	3506
3803	" " Fish, Bone and Potash............	......	0.27	2.69	2.96	3.28	3.84	1.63	2.86	8.33	8.00	5.47	4.00	3.49	5.00	7.28	23.68	35.00	3803
3804	" " Dried and Ground Fish..........	......	1.00	2.58	3.58	3.28	0.87	3.19	0.94	5.00	8.00	4.06	4.00	0.52	3.00	0.46	19.73	30.00	3804
3572	Wando Blood Phosphate............................	......	0.20	2.11	2.31	2.05	7.65	1.33	3.42	12.40	9.50	8.98	9.00	1.65	1.50	1.64	25.76	28.00	3572
3638	Waring's Market Garden Phosphate	......	1.67	1.84	3.51	2.46	6.20	0.58	0.51	7.29	....	6.78	8.00	4.41	8.00	9.68	27.07	42.00	3638
3510	" Fish Ammon. Superphosphate......	......	0.23	1.85	2.08	1.23	6.62	1.20	2.15	9.97	9.00	7.82	8.00	1.88	1.50	4.03	22.56	26.00	3510
3865	Wenderoth's Potato Fertilizer......................	......	0.10	3.64	3.74	3.28	4.95	1.33	2.43	8.71	9.00	6.28	7.00	5.24	4.00	5.05	28.95	35.00	3865
3716	" Favorite Fertilizer....................	......	0.14	6.68	6.82	5.74	0.48	6.70	4.17	11.35	11.00	7.18	....	4.45	4.00	2.95	41.35	38.00	3716
3596	Wilkinson's Economical Bone Fertilizer......	0.88	......	0.37	1.25	1.23	1.10	5.10	4.06	10.26	....	6.20	6.00	3.44	1.60	0.54	20.09	33.00	3596
3512	Williams & Clark's Potato Phosphate...........	......	0.16	2.70	2.86	2.46	6.26	1.54	0.77	8.57	8.00	7.80	7.00	6.05	6.00	5.07	28.11	38.00	3512
3605	" " " Popular Royal Bone......	......	......	1.64	1.64	0.82	6.75	0.40	1.61	8.76	8.00	7.15	7.00	2.43	2.00	1.47	20.33	28.00	3605
3606	" " " High-Grade for Potatoes.	0.25	0.11	3.13	3.49	3.69	4.82	2.94	1.98	9.74	8.00	7.76	7.00	6.55	7.00	5.39	31.24	40.00	3606
3866	" " " Ammon. Bone Super......	......	0.72	2.57	3.29	2.46	8.03	1.29	1.68	11.00	11.00	9.32	10.00	2.15	2.00	2.34	29.05	45.00	3866

GROUND BONE.

Ground bone is both a phosphatic and nitrogenous fertilizer; it is insoluble in water, but is readily decomposed by the action of the soil, and furnishes amounts of nitrogen and phosphoric acid to the crop from year to year in proportion to the fineness to which it is ground; it is less liable to adulteration than mixed fertilizers and varies in composition between reasonably narrow limits.

With very few exceptions the brands represented by the analyses here published may be considered as *pure ground bone*, inasmuch as they correspond very closely to the average composition in their percentages of nitrogen and phosphoric acid. Bones, ground fine, have a tendency under certain conditions to cake and rot, which makes them difficult to handle. To prevent this tendency certain manufacturers add preservative agents. This, while it does not injure and may perhaps improve the quality of the nitrogen and phosphoric acid, *does reduce* the actual amounts per ton of these ingredients, and should be taken into consideration in stating guarantees and fixing prices. What is termed raw or unboiled bone is perhaps the purest, though not always the best in agricultural value, as the fat prevents the full effect of the agencies in the soil which cause the decay necessary before the nitrogen and phosphoric acid can serve as food for plants. The nitrogen in boiled or steamed bones is often very low, while the phosphoric acid is correspondingly high. This is owing to the extraction of the nitrogen along with the fat.

Sample No. 3384 is a good example of the changes which may occur in the composition of bones after they have served the purpose of the glue-maker; the nitrogen is less than half the amount contained in the average bone, while the phosphoric acid is greater by nearly fifty per cent.

The methods now in use in large works of steaming bone under pressure, or of extracting with petroleum or benzine, have the advantage of improving the quality without decreasing or materially changing the relative amounts of nitrogen and phosphoric acid. The belief that "*ground bone is ground bone*" is modified by the above facts, and a knowledge of the changes likely to occur in the quality and composition is of direct value in its economical purchase.

MECHANICAL COMPOSITION.

To determine the value of bones, both the amount of nitrogen and phosphoric acid and the degree of fineness are taken into consideration; the finer pure bones are ground, the more valuable they are, provided the whole of the bone is used to secure the fineness.

A mechanical analysis of a sample of ground bone consists in dividing it by a system of sieves, into four grades, each grade having a different value for the phosphoric acid and nitrogen. It is assumed that the relative percentages of nitrogen and phosphoric acid are the same in all grades. The values are computed by multiplying the pounds of nitrogen and phosphoric acid per ton, as determined by analysis, by the per cent. of each grade; the sum of the separate values of each making the total value of the sample.

The average per cent. of fineness of the bones examined this year and the Station's valuations for the nitrogen and phosphoric acid in the different grades, are indicated in the following table:

	Average per cent. of fineness.	Nitrogen, per lb.	Phosphoric Acid per lb.
Finer than $\frac{1}{50}$ inch in diameter.........	39.0	$16\frac{1}{2}$ cents.	7 cents.
" " $\frac{1}{25}$ " " "	25.7	13 "	6 "
" " $\frac{1}{12}$ " " "	24.1	$10\frac{1}{2}$ "	5 "
Coarser " $\frac{1}{12}$ " " "	11.2	$8\frac{1}{2}$ "	4 "

CONSIDERATION OF VALUES.

The guarantees of the manufacturers are practically kept in all the samples. The average selling price of the 31 different brands is $32.74 per ton, $1.72 less than in 1889; the average Station valuation is $35.42, practically identical with the result shown last year.

The average *cost per pound* of the nitrogen and phosphoric acid in the different grades, based upon the average composition of 3.82 per cent. nitrogen and 21.36 per cent. phosphoric acid, and upon the mechanical analysis of this year, is tabulated in connection with the results secured in 1889:

	Finer than			Coarser than
	$\frac{1}{50}$ in.	$\frac{1}{25}$ in.	$\frac{1}{12}$ in.	$\frac{1}{12}$ in.
Nitrogen, 1889	16.0 cents.	12.6 cents.	10.2 cents.	8.1 cents.
" 1890	15.4 "	12.1 "	9.8 "	7.9 "
Phosphoric Acid, 1889	6.8 "	5.8 "	4.9 "	3.9 "
" " 1890	6.5 "	5.6 "	4.2 "	3.7 "

The average cost per pound of the nitrogen and phosphoric acid in the finest grade, which constitutes on the average over 39 per cent. of the whole, is 15.4 and 6.8 cents respectively. The average cost per pound of these elements, without regard to fineness, is 12.5 cents for nitrogen and 5.4 cents for phosphoric acid.

It has been shown that ground bones contain only nitrogen and phosphoric acid, that they are reasonably constant in composition and that the rate of availability of the nitrogen and phosphoric acid contained in them depends chiefly upon their mechanical composition.

For these reasons they do not admit of a strict comparison with what are known as complete fertilizers, since the fertilizing elements in these not only admit of an almost endless variety of combinations, but their value is based upon the *form* in which they exist rather than upon the mechanical condition of the materials from which they are derived. A study of the complete fertilizers examined this year, however, shows that the nitrogen is derived chiefly from organic materials; that more than one-fourth of the available phosphoric acid is what is termed reverted and similar in form to that existing in bone of the first grade; and that the average cost per pound of nitrogen is 21.8 cents, and of phosphoric acid, 10.2 cents.

These are the facts deduced from a study of the analyses made this year. It remains for the farmer to decide whether for his soil and his crops it is *always* more profitable to buy nitrogen for 21.8 cents and phosphoric acid for 10.2 cents per pound in the form of complete fertilizers, when the same elements can be bought in ground bone for 12.5 cents and 5.4 cents per pound. *In other words, shall the dollar spent for fertilizers buy 8 pounds of nitrogen or 4 1-2; shall it buy 10 pounds of phosphoric acid or 18 1-2?*

DISSOLVED BONES.

The samples examined fairly represent this class of goods.

Dissolved bones when well made are useful and often very desirable general fertilizers. The phosphoric acid and nitrogen contained in them are partly in a soluble and partly in an insoluble form, giving them the property of benefiting crops at all stages of growth, and also of exerting an influence on succeeding crops. These advantages, however, may be derived from a proper mixture of very fine bone and a superphosphate; and the cost of the nitrogen and phosphoric acid in such a mixture would be much less than in the dissolved bone.

SUPERPHOSPHATES WITH POTASH.

The superphosphates with potash are simply mixtures, and possess no special advantages. With the exception of No. 3629, excessive charges are made for work which the farmer is capable of doing quite as well for himself.

Ground Bone

Furnishing Nitrogen and Insoluble Phosphoric Acid.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY.	Station Number.
3893	Pure Ground Bone	Allentown Manufacturing Co., Allentown, Pa.	D. R. Warbasse, Huntsburgh.	3893
3578	Ground Bone	W. T. Allen, Lawrence Station, N. J.	Franklin Dye, Trenton.	3578
3881	Pure Ground Bone	H. J. Baker & Bro., New York.	D. R. Warbasse, Huntsburgh.	3881
3762	Raw Bone Meal	Baugh & Sons Co., Philadelphia, Pa.	J. B. Eckerson, River Vale.	3762
3879	Ground Bone	Brands & Read, Belvidere, N. J.	T. M. Boyer, Bridgeville.	3879
3434	Raw Bone Meal	Brown & Gilman, Philadelphia, Pa.	J. H. Denise, Freehold.	3434
3384	Bone Meal	Peter Cooper's Glue Factory, New York.	H. I. Budd, Mount Holly.	3384
3378	Bone Sweepings	Cosmopolitan Manufacturing Co., Newark, N. J.	Wm. R. Ward, Newark.	3378
3379	Bone Turnings	" " " " "	" " "	3379
3517	Pure Ground Bone	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Dennis C. Crane, Roselle.	3517
3442	Ground Bone	The Darling Fertilizer Co., Pawtucket, R. I.	J. H. Denise, Freehold.	3442
3894	Pure Raw Bone	James Hand, Seeley, N. J.	James Hand Seeley.	3894
3496	" " "	Jones & Ayars, Salem, N. J.	Woodnutt Pettit, Salem.	3496
3389	Boiled Bone	Albert S. Leigh, Princeton, N. J.	C. H. Olden, Princeton.	3389
3390	Green Bone	" " " " "	" " "	3390
3850	Celebrated Ground Bone	Lister's A. C. Works, Newark, N. J.	Chas. Kraus, Egg Harbor City.	3850

Ground Bone

Furnishing Nitrogen and Insoluble Phosphoric Acid.

Station Number.		Mechanical Analysis. Finer than 1-50th in.	Finer than 1-25th in.	Finer than 1-12th in.	Coarser than 1-12th in.	Chemical Analysis. Nitrogen.	Phosphoric Acid.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs.	Station Number.
3393	Allentown Pure Ground Bone	26	29	30	15	4.57	21.21	$35 44	$34 00	3393
3578	Allen's Ground Bone	48	26	20	6	3.73	17.58	32 04	30 00	3578
3381	Baker's Pure Ground Bone	2	6	90	2	4.12	24.88	34 12	35 00	3381
3762	Baugh's Raw Bone Meal	54	40	6	...	3.73	19.96	36 35	34 00	3762
3879	Brands & Read's Ground Bone	5	20	35	40	3.87	19.59	27 31	30 00	3879
3434	Brown & Gilman's Raw Bone Meal	38	49	13	...	4.09	19.61	35 96	32 00	3434
3384	Cooper's Bone Meal	60	16	11	13	1.82	29.08	41 41	23 00	3384
3378	Cosmopolitan Bone Sweepings	77	20	3	...	3.94	24.56	45 40	23 00	3378
3379	" Bone Turnings	94	5	1	...	4.09	25.16	48 17	30 00	3379
3517	Crocker's Pure Ground Bone	26	33	30	11	4.40	22.52	36 99	40 60	3517
3442	Darling's Ground Bone	74	15	10	1	2.57	24.40	40 16	31 50	3442
3394	Hand's Pure Raw Bone	3	18	42	37	4.08	21.12	29 05	30 00	3394
3496	Jones & Ayars' Pure Raw Bone	32	23	42	3	3.47	24.04	37 07	31 00	3496
3389	Leigh's Boiled Bone	14	32	30	24	4.44	18.68	30 38	45 00	3389
3390	" Green Bone	8	33	37	22	4.18	18.27	28 76	50 00	3390
3350	Lister's Celebrated Ground Bone	42	19	16	23	3.43	14.97	26 31	30 00	3350

Ground Bone

Furnishing Nitrogen and Insoluble Phosphoric Acid.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3585	Crescent Bone	Lister's A. C. Works, Newark, N. J.	Franklin Dye, Trenton.	3585
3684	Ground Bone	H. S. Miller & Co., Newark, N. J.	J. J. Mitchell, Whippany.	3684
3477	Pure Bone Meal	" " " " "	J. H. Denise, Freehold.	3477
3482	Ground Bone	Monmouth Fertilizer Co., Asbury Park, N. J.	" " "	3482
3405	Button Bone	L. Moritz, Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3405
3691	Pure Ground Bone	H. Preston & Sons, Greenpoint, L. I.	J. J. Mitchell, Whippany.	3691
3408	Pure Bone Meal	Sharpless & Carpenter, Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3408
3410	Swift Sure Bone Meal	M. L. Shoemaker & Co., Philadelphia, Pa.	" " " "	3410
3736	Pure Ground Bone	John I. Smith, Trenton, N. J.	Augustus Dilts, Copper Hill.	3736
3738	" " "	Taylor, Kaline & Worman, Frenchtown, N. J.	" " " "	3738
3622	Raw Bone	The Taylor Provision Co., Trenton, N. J.	Franklin Dye, Trenton.	3622
3863	Pure Ground Bone	I. P. Thomas & Son Co., Philadelphia, Pa.	Chas. Kraus, Egg Harbor City.	3863
3413	Button Bone	Emil Wahl, Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3413
3713	Pure Ground Bone	J. Wenderoth & Sons, Camden, N. J.	I. W. Nicholson, Camden.	3713
3626	Pure Bone Meal	Williams & Clark Fertilizer Co., New York.	Franklin Dye, Trenton.	3626

Ground Bone.

Furnishing Nitrogen and Insoluble Phosphoric Acid.

Station Number.		Mechanical Analysis. Finer than 1-50th in.	Mechanical Analysis. Finer than 1-25th in.	Mechanical Analysis. Finer than 1-12th in.	Mechanical Analysis. Coarser than 1-12th in.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phosphoric Acid.			Station Number.
3585	Lister's Crescent Bone	46	22	19	13	3.14	14.1[illegible]			3585
3684	Miller's Ground Bone	58	19	13	10	2.46	23.7[illegible]	[illegible]	[illegible]	3684
3477	" Pure Bone Meal	26	30	44	...	4.25	23.03	37 71	28 00	3477
3482	Monmouth Ground Bone	58	23	22	2	2.86	21.24	34 79	38 00	3482
3405	Moritz's Button Bone	16	20	39	25	4.08	23.91	34 44	34 00	3405
3691	Preston's Pure Ground Bone	58	38	2	2	4.31	18.01	29 80	37 00	3691
3408	Sharpless & Carpenter's Pure Bone Meal	39	50	11	...	3.98	21.61	38 21	33 00	3408
3410	Shoemaker's Swift Sure Bone Meal	54	35	11	...	5.34	22.45	44 47	34 00	3410
3736	Smith's Pure Ground Bone	32	33	27	8	4.20	22.41	38 02	33 00	3736
3738	Taylor, Kaline & Worman's Pure Ground Bone	16	25	49	10	4.26	21.98	34 11	32 00	3738
3622	Taylor's Raw Bone	39	26	17	18	3.38	16.66	28 28	30 00	3622
3863	Thomas' Pure Ground Bone	30	25	25	20	4.46	21.85	35 29	35 00	3863
3413	Wahl's Button Bone	42	22	18	18	3.88	24.97	39 62	34 00	3413
3713	Wenderoth's Pure Ground Bone	26	22	28	24	4.29	22.11	34 78	34 00	3713
3626	Williams & Clark's Pure Bone Meal	72	18	6	4	3.10	23.92	40 90	30 00	3626

Miscellaneous Samples.

Dissolved Bones and Superphosphates with Potash.

Station Number.	BRAND.	MANUFACTURER.	SAMPLED BY	Station Number.
3693	$25 Phosphate	Baugh & Sons Co., Philadelphia, Pa.	I. W. Nicholson, Camden.	3693
3898	Fresh Ground Bone	Bowker Fertilizer Co., Boston and New York.	J. J. Mitchell, Whippany.	3898
3838	Pure Dissolved Animal Bone	Dambmann Bros. & Co., Baltimore, Md.	D. R. Warbasse, Huntsburgh.	3838
3857	Fine Ground Bone	Mapes F. & P. Guano Co., New York.	Charles Kraus, Egg Harbor City.	3857
3406	Dissolved Bone	Sharpless & Carpenter, Philadelphia, Pa.	Theo. F. Baker, Bridgeton.	3106
3706	Improved Superphosphate	I. P. Thomas & Son Co., Philadelphia, Pa.	I. W. Nicholson, Camden.	3706
3464	Raw and Dissolved Bone	" " " " " "	Sam'l F. Woolley, Allentown.	3464
3715	Equine Guano	J. Wenderoth & Sons, Camden, N. J.	I. W. Nicholson, Camden.	3715
3880	Soluble Bone and Potash	Brands & Read, Belvidere, N. J.	T. M. Boyer, Bridgeville.	3880
3629	" " " "	E. Frank Coe, New York.	H. I. Budd, Mount Holly.	3629
3908	Superphosphate No. 2	Crocker Chemical and Fertilizer Co., Buffalo, N. Y.	J. J. Mitchell, Whippany.	3908
3910	Sickle Brand	Frederick Ludlam, New York.	" " "	3910

Miscellaneous Samples

Dissolved Bone and Superphosphates with Potash.

Station Number.		Nitrogen.					Phosphoric Acid.							Potash.					
												Available.							
				From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.		Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Chlorine.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.	Station Number.
3698	Baugh's $25 Phosphate	......	0.25	2.13	2.38	2.06	5.89	1.20	5.93	12.52	10.20	6.59	7.00	......	......	......	$22.19	$25.00	3698
3898	Bowker's Fresh Ground Bone	......	......	......	3.62	2.43	4.17	10 12	3.57	17.86	18.00	14.29	5.00	......	......	......	37.31	31.00	3898
3838	Dambmann's Pure Dissolved Ammon. Bone	......	......	......	2.96	1.91	10.70	3.27	0.78	14.75	13.00	13.97	12.00	......	......	......	32.88	37.00	3838
3857	Mapes' Fine Ground Bone	......	......	......	2.83	2.05	4 79	8.25	4.70	17.74	......	13.04	12.00	......	......	......	33.30	39.00	3857
3406	Sharpless & Carpenter's Dissolved Bone	......	......	......	2.12	1.64	5.55	4.25	5.05	14.85	11.00	9.80	......	......	......	......	25.92	30.00	3406
3706	Thomas' Improved Superphosphate	0.14	......	0.67	0.81	0.42	8.10	1.84	2.99	12.93	14.00	9.94	12.00	......	......	......	20.38	21.00	3706
3464	" Raw and Dissolved Bone	......	......	......	1.71	1.64	1.67	4.50	11.29	17.46	18.00	6.17	8.00	......	......	......	22.45	27.00	3464
3715	Wenderoth's Equine Guano	......	......	......	3.47	3.28	5.48	1.88	4.70	12.06	10.00	7.36	8.00	......	......	......	26.40	32.00	3715
3880	Brands & Read's Soluble Bone and Potash	......	......	......	......	......	3.53	2.55	2.07	8.15	9.00	6.08	......	1.76	2.50	0 23	12.99	21.00	3880
3629	Coe's Soluble Bone and Potash	......	......	......	......	......	8.73	1.98	4.51	15.22	15.00	10.71	12.00	2.57	2.80	2.68	22.16	25.00	3629
3903	Crocker's Superphosphate No. 2	......	......	......	......	......	9.87	2.15	2.64	14.66	13.00	12.02	11.00	1.47	1.36	1.54	22.13	30.00	3903
3910	Ludlam's Sickle Brand	......	......	......	......	......	7.40	1.91	4.21	13.52	12.00	9.31	11.00	2.51	3.00	0.86	20.10	31.00	3910

UNLEACHED WOOD ASHES.

3388. Unleached Canada Wood Ashes. Charles Allison, New York. Sent by J. J. Mitchell, Whippany.

3392. Western Ashes. James Hartness, Detroit, Mich. Sent by Isaac S. Dawes, Imlaystown.

3393. Jersey Ashes. Manufactured and sent by Isaac S. Dawes, Imlaystown.

3394. Canada Ashes. F. R. Lalor, Canada. Sent by Theo. F. Baker, Bridgeton.

3536. Canada Unleached Ashes. Munroe, Judson & Stroup, Oswego, N. Y. Sent by Dennis C. Crane, Roselle.

3876. Canada Ashes. Sent by Charles Kraus, Egg Harbor City.

3925. Canada Ashes. Stroup & Co., Canada. Sent by J. H. Denise, Freehold.

3926. Canada Ashes. Stroup & Co., Canada. Sent by J. H. Denise, Freehold.

	3388	3392	3393	3394	3536	3876	3925	3926
Phosphoric Acid	1.11	2.48	1.54	1.38	1.51	1.98	1.16	0.95
Potash	4.81	5.80	3.92	4.24	2.89	5.54	7.59	3.75
Lime	31.94	28.44	12.70	32.50	36.46	30.20	47.98	34.72
Selling Price per Ton	$18.00	$13.50	......	$13.00	$14.00	$13.50	......	......

Canada unleached ashes are usually guaranteed to contain 6 per cent. of potash. The average composition of 11 samples previously analyzed by this Station is

Phosphoric Acid.	Potash.	Lime.
1.75 per cent.	5.58 per cent.	33.60 per cent.

That ashes are not a uniform product is evident from the variations shown in the above samples. But two of the samples are as good as the average, nor is the highest selling price attached to the best sample. The amount of the plant-food elements contained in an average sample of ashes can be bought for about $9 per ton. It is the general experience, however, that on certain soils the agricultural effect of the phosphoric acid, potash and lime is greater in wood ashes than in a proportionate mixture of the same elements in other forms. This is believed to be due to the special form or combination of the ingredients in ashes which, in addition to their direct benefit, exert a favorable mechanical effect upon the soil.

3717. Precipitated Carbonate of Lime, from the Solway Process

Co., Syracuse, N. Y. Sent by J. H. Maiers, Troy, N. Y. It contains 51.20 per cent. calcium oxide, equivalent to 91.40 per cent. calcium carbonate. At $4 or $5 per ton, the price at which it is claimed it can be sold in New Jersey, and the form in which it exists, make it well worth a trial by those who find lime useful in their system of farming. Owing to its physical character and its extreme fine division, it could also serve as an excellent medium for the application of insecticides.

3919. Marl, from the pits of G. A. Weindenmayer, Oceanic, N. J. From stock of J. W. Newell, New Brunswick. It contains 0.92 per cent. total phosphoric acid, 0.17 per cent. soluble potash and 1.54 per cent. lime. As phosphoric acid and lime are the chief ingredients in marl, this sample would be considered below the average in quality. The fertilizing elements in it could be bought in equally available forms for less than $1 per ton.

3380. Wool Waste, from cloth factories in Philadelphia, Pa. Sent by J. J. Albertson, Magnolia, N. J. Selling price, $3 per ton. It contains 3.27 per cent. nitrogen and 1.91 per cent. potash. With nitrogen at 8 cents and potash at 4½ cents per pound, the value would be $6.95 per ton. Wool waste is used to a large extent in certain parts of the State and gives excellent satisfaction where lasting effects are desirable.

3927. Muck, taken from the upper two feet of the beds of Charles B. Horner, Mount Holly, N. J.

3928. Muck, taken from the third foot of the beds of Charles B. Horner, Mount Holly, N. J.

	3927 Per cent.	3928 Per cent.
Water	78.428	45.092
*Organic Matter	14.902	11.256
Insoluble Matter	5.072	39.525
Phosphoric Acid	0.027	0.055
Potash	0.060	0.232
Undetermined	1.511	3.840

3929. Buckwheat Hulls. Sent by A. L. Conover, Clinton. They contain 20.00 per cent. water, 0.72 per cent. nitrogen, 0.19 per cent. phosphoric acid, 0.60 per cent. potash, and 2.79 per cent. ash. Considering the nitrogen, phosphoric acid and potash as being worth the same as in barn-yard manure, namely, 12, 6 and 4 cents per pound respectively, the value of this sample as a fertilizer is $2.44 per ton.

*Sample 3927 contains 0.291 per cent., and sample 3928, 0.248 per cent. of nitrogen.

III.

AGRICULTURAL RELATIONS OF FERTILIZERS.

EXPERIMENTS WITH NITRATE OF SODA ON TOMATOES.

The results, secured from field experiments with nitrate of soda upon tomatoes, conducted by this Station in 1889, warranted the following general conclusions:

1. That nitrate of soda, while increasing the yield, did not do so at the expense of maturity—
   a. When a small quantity was used.
   b. When a large quantity was used in two applications.

2. That nitrate of soda did increase the yield at the expense of maturity—
   a. When used in large quantities in one application.

3. That nitrate nitrogen was the ruling element in the growth of tomatoes, and that its best effect was dependent upon—
   a. The method of application.
   b. The presence or absence in the soil of a full supply of the mineral elements, phosphoric acid and potash.

Experiments with this crop were carried out again in 1890. The results, while differing somewhat in detail, not only verify those conclusions, but warrant another very important one, viz.:

4. That nitrate of soda properly used is a profitable fertilizer for tomatoes.

The plan of the experiment included a test of the effects of nitrate of soda:

a. When used alone—.
   1. In different quantities in one application.
   2. In different quantities in two applications.

b. When used in connection with large quantities of phosphoric acid and potash—
   1. In different quantities in one application.
   2. In different quantities in two applications.

Two experiments were carried out, one upon the farm of C. M. Housell, of Dunham's Corners, Middlesex county, and the other upon that of B. Frank Sharp, of Bridgeton, Cumberland county.

Each experiment occupied twelve plots, each one-twentieth of an acre in area. The dimensions of the whole area were 96 by 272 feet, each plot being 8 feet wide and 272 feet long.

EXPERIMENT OF MR. HOUSELL.

The following tabular statement shows the number of plots, the amounts of fertilizer used, and the dates of their application:

No. of Plot.	KIND OF FERTILIZER.	Quantity.	DATE OF APPLICATION OF NITRATE OF SODA. On May 9th.	On June 16th.
1	Unfertilized	....	....	....
2	Nitrate of Soda	8 lbs.	8 lbs.	....
3	Nitrate of Soda	8 "	4 "	4 lbs.
4	Nitrate of Soda	16 "	16 "	....
5	Nitrate of Soda	16 "	8 "	8 lbs.
6	Muriate of Potash	8 "	....	....
	Bone-Black Superphosphate	16 "	....	....
7	Muriate of Potash	8 "	....	....
	Bone-Black Superphosphate	16 "	....	....
	Nitrate of Soda	8 "	8 lbs.	....
8	Muriate of Potash	8 "	....	....
	Bone-Black Superphosphate	16 "	....	....
	Nitrate of Soda	8 "	4 lbs.	4 lbs.
9	Muriate of Potash	8 "	....	....
	Bone-Black Superphosphate	16 "	....	....
	Nitrate of Soda	16 "	16 lbs.	....
10	Muriate of Potash	8 "	....	....
	Bone-Black Superphosphate	16 "	....	....
	Nitrate of Soda	16 "	8 lbs.	8 lbs.
11	Fine Barn-yard Manure	1 ton.	....	....
12	Unfertilized	....	....	....

A plot adjoining the one used in 1889 was selected in order that all controllable conditions might correspond as near as possible with those existing then, and that the same general order might be observed in the study of the results. The land consists of a sandy loam, is level, well drained, of uniform quality, and in a good state of cultivation. It had been used for more than ten years in growing market-garden produce. The whole area had been uniformly cropped and fertilized for the three preceding years.

APPLICATION OF FERTILIZERS.

With the exception of the second application of nitrate of soda, all fertilizers were applied and well raked into the soil previous to setting the plants. The mixed minerals for plots 6, 7, 8, 9 and 10, and the manure on plot 11, were applied broadcast over the whole of each plot.

Each application of nitrate of soda was distributed evenly over about one-half of the space occupied by the row.

The method of application of the nitrate is of great importance, and, while distinctly stated as above in Bulletin 63 of this Station, complaints have been received from farmers that their plants were killed by it. In the cases reported to us, the plants were injured because the directions given were not followed. In one case the farmer set his plants in a hill in which he had put a handful of nitrate; in another, much larger quantities were used in the second application than were recommended, and also distributed in an improper manner. In the experience of the Station and of practical farmers who did follow the directions given, there was no injury from the use of nitrate of soda. This point illustrates the necessity of carefully observing the precautions usually given when the use of concentrated forms of plant-food is recommended.

FIELD RECORD.

As stated in Bulletin 63, the variety grown had been developed by Mr. Housell from crossing leading varieties. The fruit was large, solid, matured early, and was well adapted for market-gardening.

The seeds from which the plants were secured were planted under glass in February, 1890. Only strong and stocky plants were

selected for the experiment. They were set four feet apart each way, with two rows on each plot, giving 136 plants per plot.

The plots were laid out and the fertilizers applied on May 9th.

The plants were set on May 9th, 10th and 13th, beginning at the ends, and setting from side to side across the whole number of plots.

The whole area under experiment was thoroughly cultivated with horse-cultivator five times, lengthwise of the plots only, and handhoed five times during the season. The second application of the nitrate was made on June 16th, at which time the tomatoes were beginning to set.

Notes taken on June 14th showed the plants on plot 1, 6 and 12 to be uniform in size and color, those on plot 11 somewhat darker in color and more vigorous, and the plants on all the nitrated plots much larger than the others and of a dark-green color.

Observations made on July 4th showed an enormous growth of vines on all the nitrated plots, tomatoes set full, large and with a few beginning to ripen. On plots 1 and 12 the fruit and vines were uniform in size, but much smaller than on the other plots. On plot 6 the vines were larger than those on 1 and 12, but were less vigorous and much lighter in color than those on the nitrated plots. On plots 3 and 5 the vines were much the heavier, and all the plots with nitrate alone were more promising than 7, 8, 9 and 10, where phosphoric acid and potash were used. There was no noticeable difference in the maturity of the fruit except on plot 5, upon which, owing to the unusually heavy vines, the fruit appeared less mature than on the other plots, the quantity of fruit being apparently proportionate to the size of the vines.

On July 14th it was the judgment of observers that the greatest yield would be secured from the use of nitrate of soda alone, and the earliest tomatoes from the unmanured land and complete fertilizers.

The season was favorable throughout, the warm weather and even distribution of rain and sunshine tending to normal development of the crop.

GATHERING THE CROP.

The tomatoes were injured somewhat in the early part of August by the corn worm, though not to such an extent as to impair results. The tomatoes were, as a rule, picked every other day. With the exception of July 28th and August 2d and 4th only merchantable

tomatoes were picked and weighed. On these dates the damage from the worm and rot was the greatest, and the total pickings were sorted and a record made of the weight of merchantable tomatoes only.

The management of the experiment crop was business-like throughout. All wastes were avoided as far as possible and the fruit prepared for market in an attractive manner. As in all field experiments conducted by this Station, the Chemist exercised a direct supervision over the preparation and application of the fertilizers and the laying out of the plots. The remainder of the work was done by Mr. Housell, and credit is due him for his interest in the work, his valuable suggestions and the intelligent and careful manner in which all the details of the experiment were carried out and the results recorded.

The results of the experiment represented in all respects actual practice of farmers growing the crop for the general market.

An exact copy of the yield from the plots at different pickings, arranged to correspond to the different prices of tomatoes ruling during the season in the New Brunswick market, is shown in the following table:

TABLE I.

Yield and Selling Price of Tomatoes at Different Pickings.

NUMBER OF PLOT.	DATE OF PICKING.									Total Yield per Plot.	Total Value per Plot.
	July 7–9.	July 16–19.	July 22–29.	July 30.	August 1.	August 2.	August 4, 5.	August 6–28.	September 1–9.		

The selling price of the tomatoes from these plots ranged from $3 to 20 cents per basket as against a range of from $2 to 15 cents in 1889. As then stated, what may be considered early tomatoes in the average season in these markets must be sold during the first week in August. This year the price dropped from 75 cents on August 2d to 40 cents on August 4th, and to 25 cents on the 6th. In 1889 the price dropped on August 2d from 75 cents to 50 cents, and on August 5th to 25 cents, so that in 1889 50 cents per basket marked the limit and in 1890, 40 cents. These points have an influence in studying early maturity and lead to a question of great importance to the market-gardener.

I. DOES NITRATE OF SODA, USED EITHER ALONE OR IN CONNECTION WITH PHOSPHORIC ACID AND POTASH, INCREASE THE YIELD AT THE EXPENSE OF MATURITY?

In studying maturity from the standpoint of the market-gardener two points must be taken into consideration—

1. *The yield at selling prices above the average price secured for the whole crop.*
2. *The relation of the value of that yield to the value of the entire yield.*

Table II. shows what per cent. of the whole yield was early tomatoes and also what per cent. of the total money value of the whole crop was represented by the money value of that yield.

TABLE II.

The Relation of the Yield and Value of Early Tomatoes to the Total Yield and Total Value of Crop.

Number of Plot.	Total Yield in Pounds per Plot.	Yield in Pounds per Plot Sold at Prices Ranging from 40 cts. to $3 per Basket.	Per Cent. of the Whole Yield per Plot Sold at Prices Ranging from 40 cts. to $3 per Basket.	Total Value of Yield per Plot.	Value of Yield per Plot Secured at Prices Ranging from 40 cts. to $3 per Basket.	Per Cent. of Total Value per Plot of Yield Sold at Prices Ranging from 40 cts. to $3 per Basket.
1	1332.7	371.9	27.9	$18 32	$9 84	53.7
2	1796.2	435.4	24.2	23 43	11 39	48.6
3	2044.1	421.6	20.6	24 48	10 12	41.3
4	2014 6	359.9	17.9	24 17	9 47	39.2
5	1930.4	465.1	24.1	23 94	10 95	45.9
6	1618.7	369.2	22.8	20 43	9 46	46.3
7	1673.0	370.3	22.1	20 91	9 39	44.9
8	1858.5	444.8	23.9	23 07	10 52	45.6
9	1935.1	363.6	18.8	21 85	8 02	36.7
10	1961.4	392.6	20.0	23 56	9 63	40.9
11	1607.1	435.6	27.1	20 82	10 39	49.9
12	1352.1	351.4	26.0	17 74	8 80	49.6

Nitrate of soda was effective in increasing the total yield in every case. It was effective in increasing maturity from both the standpoints of yield and money value on six out of the eight plots upon which it was applied, though the average per cent. of early yield and of its money value was less than on both the manured and unmanured land. Maturity was seriously retarded by nitrate of soda used in large quantities on plots 4 and 9. On all other plots the variations due to quantity used and method of application are not marked and are therefore comparable with each other.

Grouping the results secured from nitrate alone on plots 2, 3 and 5,

from nitrate in connection with mineral elements on 7, 8 and 10, and from nitrate in large quantities in one application, both alone and in connection with minerals, on 4 and 9, and comparing them with that secured on 1 and 12, without manure, the general effect of nitrate upon early yield is more clearly shown:

MODE OF TREATMENT.	Total Yield in Pounds.	Increased Yield in Pounds.	Per Cent. of Increase in Yield.	Total Value.	Increased or Decreased Value.	Per Cent. of Increased or Decreased Value.
Unfertilized	361.7	....	....	$9 32	....	......
Nitrate Alone	440.7	79.0	21.8	10 82	$1 50	16.1
Nitrate in Connection with Minerals	402.6	40.9	11.3	9 85	53	5.7
Nitrate in Large Quantities in One Application	361.7	....	....	8 75	—57	—6.1

By the use of nitrate alone, the yield is increased by 21.8 per cent. and the value by 16.1 per cent.; by nitrate in connection with minerals the yield is increased by 11.3 per cent. and the value by 5.7 per cent.; while with the single application of large quantities of nitrate, both alone and in connection with minerals, there is no increase in yield and a decided decrease in its value.

With the exception, therefore, of plots 4 and 9, *nitrate of soda increased both the yield and money value of early tomatoes.*

These results not only emphasize the general conclusions reached last year—

1. That nitrate of soda *did not* increase the yield at the expense of money value of early tomatoes when applied in *small quantities*, or in *large quantities* in *two applications*. This was equally true both when used alone and when used in connection with phosphoric acid and potash.

2. That nitrate of soda *did* increase the yield at the expense of money value of early tomatoes, when *large quantities* were added in

one application, in the presence of a sufficient excess of phosphoric acid and potash; but also warrant a third, viz.:

3. That properly-used, nitrate of soda is a profitable fertilizer for tomatoes.

This point is still further emphasized by the experience of Mr. Theodore F. Baker, of Bridgeton, N. J., a practical and successful market-gardener. In a recent letter in regard to his crop, he says:

"The early tomato plants were transplanted to the open field on May 2d and 3d, the soil having been previously treated with compost and commercial fertilizers. On May 6th one ounce to the hill of nitrate of soda was applied, during a moderate rain. This produced a marked effect in a few days and a most vigorous growth followed. On May 26th the second application of nitrate of soda of one and one-half ounces per hill was made. This also had a very beneficial effect, although a few plants were lost from a mistake in the mode of applying it. Although I gave the man who applied it explicit directions and repeatedly charged him not to apply it too near the plants which now spread over the ground, he went according to his own judgment, and, as a result, in a short time many of the vines turned yellow and became leafless, as well as stemless. I am perfectly satisfied, however, that I lost nothing by the application, as the balance of the crop was all that could be desired.

"On June 16th I picked my first ripe tomatoes—four quarts. On June 20th I picked the first basket, and up to June 30th there had been picked and sold $44.20 worth of tomatoes from about 1,900 hills. After that date they were picked three times a week until July 28th, when the crop was harvested. I am more and more convinced each year *that nitrates are essential for the quick growth of the tomato and will pay better than any other fertilizer*. Another and most important fact has proved itself in my experiment, namely, to apply nitrate with care and at a proper distance from the plants."

INFLUENCE OF SEASON ON THE EFFECT OF NITRATE OF SODA.

II. DOES NITRATE OF SODA HAVE THE SAME EFFECT WITHOUT REGARD TO SEASON?

The actual yield of early tomatoes on the unmanured land, in 1890, was 89.4 per cent. greater, and the value 77.5 per cent. greater than in 1889. The yield from manuring with nitrate of soda was but 53.8 per cent. greater, and the value 25.5 per cent. greater than in 1889.

The increased yield of early tomatoes from the use of nitrate in 1890 was 12.4 per cent., with an average increased value of 6.6 per cent. In 1889 the increased yield was 38.5 per cent., with an average increased value of 50.9 per cent. If plots 4 and 9, on which the nitrate exerted an unfavorable influence in both seasons, are excluded, the above ratio is not materially changed.

It is shown, therefore, that while the relative effect of nitrate of soda is the same each year for the different quantities and methods of application, the actual effect on both yield and value of early tomatoes is much less in 1890 than in 1889. In other words, those favorable conditions of season which increased the yield by 89.4 per cent. on the unmanured land of the same general character and fertility, appreciably lessened the actual effects of nitrate of soda.

The third question requiring study is:

III. WHAT CONDITIONS GOVERN IN SECURING THE HIGHEST YIELD FROM THE USE OF NITRATE OF SODA?

The calculations of yields and financial results in the subsequent tables are based upon full stand. There were very few plants lost on any of the plots, and in making the calculations it was assumed that the yield and value of the total product of full stand would have been proportionately the same as ruled for the actual product secured. The variations in weight per basket of tomatoes from the different plots, while noticeable, were too small to be taken into consideration. The average weight per basket of 15 quarts was 29 pounds:

TABLE III.

Yield and Value of Crop Per Acre, Calculated to Full Stand, for 1889 and 1890.

Number of Plot.	ACTUAL YIELD.				YIELD CALCULATED TO FULL STAND.			Value of Crop Calculated to Full Stand.	
	Number of Plants.		Baskets.		Number of Plants.	Baskets.			
	1889.	1890.	1889.	1890.		1889.	1890.	1889.	1890.
1	2,660	2,660	827	919	2,720	847	940	$343 58	$374 66
2	2,560	2,700	906	1,239	2,720	963	1,248	372 09	472 06
3	2,620	2,680	984	1,410	2,720	1,007	1,431	374 98	496 90
4	2,520	2,660	886	1,389	2,720	956	1,420	341 73	494 30
5	2,620	2 720	947	1,331	2,720	984	1,331	390 14	478 80
6	2,500	2,680	697	1,116	2,720	758	1,133	299 85	414 70
7	2,520	2,660	881	1,154	2,720	951	1,180	352 95	427 63
8	2,560	2,680	1,050	1,282	2,720	1,116	1,301	415 01	468 28
9	2,500	2,600	968	1,335	2,720	1,054	1,396	363 61	457 17
10	2,500	2,660	1,052	1,353	2,720	1,145	1,383	428 45	481 83
11	2,560	2,680	732	1,108	2,720	778	1,125	279 65	422 61
12	2,520	2,700	671	932	2,720	725	939	259 91	357 42

The total yield on the unmanured plots is practically identical, and is therefore used as a basis for comparing the effects of the different methods of fertilization.

The barn-yard manure on plot 11 increased the yield at the rate of 185 baskets per acre; the mixed minerals alone on plot 6, at the rate of 193 baskets per acre. The increase due to these methods of manuring, while a gain over that secured in 1889, is still much less than that due to nitrate of soda used either alone or in connection with phosphoric acid and potash.

The range in yield from the average of the unmanured land, 940 baskets per acre, to the highest, 1,431 baskets, from the use of small quantities of nitrate in two applications, is 491 baskets. The yield from nitrated plots ranges from 1,180 baskets on plot 7 to 1,431

baskets on plot 3, or 251 baskets. The least effective use of nitrate of soda is therefore an increase of 240 baskets per acre.

A comparison of the results of 1889 and 1890 shows that the average increase in total yield, due to nitrate manuring, was 297 baskets, or 40 per cent., in 1889, and 396 baskets, or 42.1 per cent., in 1890. In other words, the application of an average of 240 pounds of nitrate of soda per acre, produced, in 1889, 297 baskets of tomatoes, and in 1890, 396 baskets. The increased effect of an equal amount of nitrogen as nitrate in 1890 over 1889 was, therefore, equivalent to 99 baskets of tomatoes, or 33.3 per cent.

It was shown in the study of maturity, that nitrate of soda, while it did not increase the yield at the expense of maturity, *i. e.* produce less early tomatoes than the unmanured land, did not increase the maturity in the same ratio as the yield. This result exerts a marked influence on the value of total yields, since a further calculation shows that the increased yield of 396 baskets, or 42.1 per cent., in 1890, increased the value of the total crop but $106.08, or 29 per cent., while the increase in yield of 297 baskets, or 40 per cent., in 1889, increased the value of the total crop by $119.96, or 46.2 per cent. It is clearly shown, therefore, that under the conditions which existed this year, the nitrate of soda was more completely used by the crop than in 1889, but resulted in produce of lower value. These results are chiefly of interest in showing the influence of season, and do not change the general conclusion in regard to the value of nitrate of soda as a fertilizer for tomatoes.

Comparison of Average Increased Yields.

Yield per acre of unmanured land	940	baskets.
Increased yield per acre due to mineral elements alone	193	"
" " " " " " twenty loads of barn-yard manure	185	"
Average increased yield per acre due to nitrate of soda alone	417	"
" " " " " " " " " " with minerals	375	"

Variations in Increased Yield Due to Different Methods of Application of Nitrate of Soda.

ALONE.			WITH ADDITION OF MINERALS.		
160 pounds in one application	308	baskets.	160 pounds in one application	240	baskets.
160 " " two applications	491	"	160 " " two applications	361	"
Gain from second application	183	"	Gain from second application	121	"
320 pounds in one application	480	"	320 pounds in one application	456	"
320 " " two applications	391	"	320 " " two applications	443	"
Gain from one application	89	"	Gain from one application	13	"

Variations in Increased Yield Due to Different Quantities of Nitrate of Soda.

ALONE.			WITH ADDITION OF MINERALS.		
160 pounds in one application	308	baskets.	160 pounds in one application	240	baskets.
320 " " " "	480	"	320 " " " "	456	"
Gain from larger	172	"	Gain from larger	216	"
160 pounds in two applications	491	"	160 pounds in two applications	361	"
320 " " " "	391	"	320 " " " "	443	"
Gain from smaller	100	"	Gain from larger	82	"

In the methods of manuring tomatoes included in this experiment, nitrate of soda was superior to both barn-yard manure and mineral elements alone. Nitrate of soda alone was more effective than nitrate in connection with the mineral elements. It is also shown that when *small quantities* of nitrate of soda are used, either with or without phosphoric acid and potash, decided gains are derived from the *second application*. When *large quantities* are used, the second application is a *disadvantage*, either alone or in the presence of a sufficient excess of phosphoric acid and potash.

The comparison of yields from different quantities of nitrate of soda shows that in three cases out of four the *greater increase* is secured from the *larger quantity*.

The conclusions indicated by these results are still in accord with those secured in 1889 in showing that nitrogen as nitrate is the most effective element in the growth of tomatoes, and that its best effect is governed, other things being equal, by the conditions of:

1. *Quantity applied.*
2. *Method of application.*
3. *A full supply of phosphoric acid and potash.*

It was shown, however, that the direct application of phosphoric acid and potash under the conditions existing this year was unnecessary.

IV. FINANCIAL CONSIDERATIONS.

In the preceding sections the study has been directed entirely to *yield*. The aim of the farmer, however, is to obtain the greatest *clear gain* from his crop, rather than mere increase in yield. To him the vital question is:

WHAT CONDITIONS GOVERN IN OBTAINING THE GREATEST FINANCIAL PROFIT FROM THE USE OF NITRATE OF SODA?

TABLE IV.

Net Value of Crops Per Acre on the Different Plots for 1889 and 1890.

Number of Plot.	Kind of Fertilizer.	Quantity per Acre.	Date of Application of Nitrate of Soda. On May 7th, 1889.	On May 9th, 1890.	On June 12th, 1889.	On June 16th, 1890.	Cost of Fertilizer per Acre.	Total Value of Crop per Acre. 1889.	1890.	Net Value of Crop per Acre. 1889.	1890.
		lbs.	lbs	lbs.	lbs.	lbs.					
1	*Unfertilized	....	......	......	......	......	....	$343 58	$374 66	$343 58	$374 66
2	Nitrate of Soda	160	160	160	......	......	$4 00	372 09	472 06	368 09	468 06
3	Nitrate of Soda	160	80	80	80	80	4 00	374 98	496 90	370 98	492 90
4	Nitrate of Soda	320	320	320	......	......	8 00	341 78	494 80	333 78	486 80
5	Nitrate of Soda	320	160	160	160	160	8 00	390 14	478 80	382 14	470 80
6	Muriate of Potash Superphosphate	160 320	....	....	....	....	7 20	299 85	414 70	292 65	407 50
7	Muriate of Potash Superphosphate Nitrate of Soda	160 160 320	 160	 160	....	....	11 20	352 95	427 63	341 75	416 43
8	Muriate of Potash Superphosphate Nitrate of Soda	160 160 320	 80	 80	 80	 80	11 20	415 01	468 28	403 81	457 08
9	Muriate of Potash Superphosphate Nitrate of Soda	160 160 320	 320	 320	....	....	15 20	363 61	457 17	348 41	441 97
10	Muriate of Potash Superphosphate Nitrate of Soda	160 160 320	 160	 160	 160	 160	15 20	428 45	481 83	413 25	466 63
11	Fine Barn-yard Manure	20 tons	......	......	......	......	30 00	279 65	422 61	249 65	392 61
12	Unfertilized	....	......	......	......	......	....	259 91	357 42	259 91	357 42

* Eight tons Barn-yard Manure and 400 lbs. Complete Fertilizer were applied on plot 1 of 1889 experiment in summer of 1888; cost $15.

Aside from the extra cost of handling an increased crop, the only modifying condition is the cost of fertilizers; deducting this cost, we have the value of the crops on the different plots reduced to a uniform basis.

The net value of the crop on the unmanured plots is $366.04.

The highest net value of crop, $492.90, was secured on plot 3, an increase of $126.86 from the most effective use of nitrate of soda.

Comparison of Average Increased Value of Crops.

Net value of crops on unmanured land	$366 04
" " " increased crop on manured land	26 57
" " " " " from use of mineral elements alone	41 46
Average net value of increased crop from use of nitrate of soda alone	113 47
" " " " " " " " " " with minerals	79 49

Variations in Net Gain Due to Different Methods of Application of Nitrate of Soda.

ALONE.		WITH MINERAL ELEMENTS.	
160 pounds in one application	$102 02	160 pounds in one application	$50 39
160 " " two applications	126 86	160 " " two applications	91 04
Gain from second application	$24 84	Gain from second application	$40 65
320 pounds in one application	$120 26	320 pounds in one application	$75 93
320 " " two applications	104 76	320 " " two applications	100 59
Gain from one application	$15 50	Gain from second application	$24 66

Variations in Net Gain Due to Different Quantities of Nitrate of Soda.

ALONE.		WITH MINERAL ELEMENTS.	
160 pounds in one application	$102 02	160 pounds in one application	$50 39
320 " " " "	120 26	320 " " " "	75 93
Gain from larger	$18 24	Gain from larger	$25 54
160 pounds in two applications	$126 86	160 pounds in two applications	$91 04
320 " " " "	104 76	320 " " " "	100 59
Gain from smaller	$22 10	Gain from larger	$9 55

The smallest net gains are secured from the use of barn-yard manure; the largest from nitrate of soda alone. In three cases out of four net gains are increased by *two applications* of nitrate of soda. In three cases out of four the 320 pounds of nitrate of soda per acre produces greater net gains than 160 pounds.

These conclusions are substantially identical with those secured from the study of yields, and show that *financial profits* from the use of nitrate of soda are also governed by the *quantity applied*, the *method of application* and a *full supply in the soil of mineral elements*.

V. HOW FAR CAN THE RESULTS OF THIS EXPERIMENT ON TOMATOES BE APPLIED IN DETERMINING LINES OF PRACTICE ON OTHER FARMS?

It was stated in Bulletin 63, concerning the results secured from the use of nitrate of soda on tomatoes, that the conclusions then reached might be modified *in certain particulars* by further investigation. The differing conditions existing this year were soil and season. The previous treatment of the soil was identical with that in 1889, and it is believed and assumed that, so far as mechanical condition and quantity of plant-food contained were concerned, the conditions of soil were not widely different from those existing in 1889.

Under the season conditions existing in 1889, the experiment showed that the soil, without manuring, furnished sufficient available nitrogen per acre for the normal production of 10.5 tons of tomatoes; with the addition of phosphoric acid and potash, enough for 11 tons; and manuring with 160 pounds of nitrate of soda, equivalent to 25 pounds of actual nitrogen, enough phosphoric and potash for 14.6 tons. The soil this year, without manure, furnished sufficient available nitrogen per acre for 13.6 tons; with the addition of phosphoric acid and potash, enough for 16.4 tons; and manuring with 160 pounds of nitrate of soda, equivalent to 25 pounds of actual nitrogen, enough phosphoric acid and potash for 20.7 tons. The elements in the soil, which had been supplied in previous years almost entirely in the form of barn-yard manure, were therefore relatively much more available than in 1889; the phosphoric acid and potash so much more so as to make nitrogen the only needed element. The elements in the manure applied, in 1889, increased the yield 20 per cent., against an increase of 8 per cent. in 1890, yet the nitrogen in it amounting to eight times as much as in 160 pounds of nitrate of soda, was not sufficiently available to increase the yield possible from the amount of phosphoric acid and potash indicated as present in the soil.

These facts strongly emphasize the statement made last year, viz., that farmers should know the average capacity of their soils for crops, and also the kind and amount of the different elements applied and removed from their fields. Such knowledge alone can guide in the proper application of the results of any experiment. The important fact that tomatoes are a quick-growing crop must be kept in mind,

and also that maximum yields depend upon a full supply of *immediately* available nitrogen.

EXPERIMENT OF MR. SHARP.

Number of Plot.	FERTILIZER. Kind.	FERTILIZER. Quantity per Plot.	DATE OF APPLICATION OF NITRATE OF SODA. On June 5th.	DATE OF APPLICATION OF NITRATE OF SODA. On July 4th.	TOTAL YIELD. Pounds per Plot.	TOTAL YIELD. Tons per Acre.
1	Unfertilized............	....	....	....	1,091	10.91
2	Nitrate of Soda........	8 lbs.	8 lbs.	....	878	8.78
3	Nitrate of Soda........	8 "	4 "	4 lbs.	927	9.27
4	Nitrate of Soda........	16 "	16 "	....	887	8.87
5	Nitrate of Soda........	16 "	8 "	8 lbs.	878	8.78
6	Superphosphate..... Muriate of Potash.....	16 " 8 "	....	....	927	9.27
7	Nitrate of Soda........ Superphosphate...... Muriate of Potash....	8 " 16 " 8 "	8 lbs.	....	994	9.94
8	Nitrate of Soda........ Superphosphate....... Muriate of Potash.....	8 " 16 " 8 "	4 "	4 lbs.	959	9.59
9	Nitrate of Soda........ Superphosphate....... Muriate of Potash.....	16 " 16 " 8 "	16 "	....	1,039	10.39
10	Nitrate of Soda........ Superphosphate........ Muriate of Potash.....	16 " 16 " 8 "	8 "	8 lbs.	1,019	10.19
11	Barn-yard Manure...	1 ton.	....	....	1,187	11.87
12	Unfertilized............	....	....	....	882	8.82

The results of this experiment are published chiefly as a matter of record.

The land was a clay loam, level, well drained, in a good state of fertility, and considered well adapted to the growth of tomatoes.

The whole work of the experiment was carried out by Mr. Sharp in a careful and intelligent manner, but the season was of such a character as to render it inadmissible to draw any conclusion from the results secured. The fertilizers were applied, and plants set on June 5th, from which date until the latter part of July there was practically no rain. With the exception of plot 11 the plants did not grow, and many died, 400 being reset on June 17th, and several as late as June 25th. Throughout the month of August the weather was warm and wet, causing an enormous growth of vines, when under proper conditions the fruit should have been growing. There were also other conditions which seemed to prevent a setting of the fruit, many of the best-looking vines having no fruit at all, these blighted vines being unevenly distributed throughout the different plots. Much of the fruit was lost, owing to the very wet weather at time of ripening.

The conditions which existed for this field were true for the other fields on the farm of Mr. Sharp, and also for a large section of Cumberland county. The crop in other sections of the State, notably in Salem county, was fully up to the average of 8 tons per acre. Statistics secured from the most trustworthy sources, indicate a crop grown for the canneries of 80,000 tons, the product of 10,000 acres. The acreage and yield of tomatoes grown for the general markets were greater than in 1889, and better prices were also secured, indicating that the value of the total crop in the State was quite as great as in previous years.

EXPERIMENTS WITH FERTILIZERS UPON POTATOES.

Successful growers of potatoes claim that, where soil and season conditions are favorable, crops of maximum profit depend upon the selection of seed, method of planting and cultivation, and the proper application of manures. In order to ascertain the actual practice in these particulars, the following queries were sent to about one hundred of the leading growers of the State:

1. What crop usually precedes potatoes, and how fertilized or manured?
2. Method of planting; including method of cutting seed, depth of seed, width of rows, etc.
3. Kind of manure or fertilizer used. Amount per acre and method of application.

4. Method of cultivation.

5. Variety used and average yield per acre.

6. Average cost per acre of preparation of land, planting, cultivating and digging.

The replies show a marked uniformity of practice, except in the amount of the plant-food furnished by the manures used. It may be stated as follows: Precede with a crop of corn treated with 10 or 12 tons of barn-yard manure broadcast; prepare the ground thoroughly; cut the potatoes with one or two eyes and plant 4 to 5 inches deep in rows furrowed 3 feet apart, placing the pieces 12 to 15 inches apart in the row; broadcast barn-yard manure at rate of 10 to 20 loads per acre, and add chemical manures in the row at rate of 300 to 600 pounds per acre; harrow before potatoes come up, and continue once or twice a week until plants are three inches high; then cultivate three or four times, or as often as possible until the vines have their growth. The leading varieties reported were, in their order, Early Rose, Silver Lake, Mammoth Pearl, Beauty of Hebron and White Star. The yield reported ranged from 100 to 450 bushels per acre, 20 per cent. of the number reporting more than 200 bushels, and but 6 per cent. less than 150 bushels per acre. The cost of the crop, not including the manure or fertilizer, averaged $30 per acre.

During the past year this Station has conducted experiments which, leaving out all other questions of general practice, bear directly upon fertilization, and which it is hoped shall be but the beginning of a careful study of the use of barn-yard and chemical manures on the potato crop. The plans may be modified in minor details in the future, but the main objects will continue to be a test:

1. Of the different methods of manuring, viz.:
   a. With barn-yard manure alone.
   b. With chemical manures alone.
   c. With a combination of barn-yard and chemical manures.

2. Of the relative effect, upon both the yield and quality, of the different commercial forms of potash salts, viz., muriate of potash, sulphate of potash and kainit.

3. Of the effect of nitrate of soda when used:
   a. In one application.
   b. In two applications.

While the results from single experiments may not be applicable to all conditions of soil and season, such conclusions from them as seem to be warranted by the data secured will be published each year. The chief points brought out by the experiments conducted this year were:

1. That the best results were secured when chemical manures were used in connection with barn-yard manure.

2. That kainit was less effective than either muriate or sulphate of potash, and that sulphate of potash did not produce larger yields than muriate.

3. That nitrate of soda did not prove a valuable fertilizer for potatoes.

4. That potash does influence the composition of potatoes, and that of the different commercial forms the sulphate is the most valuable.

LOCATION OF EXPERIMENTS. DESCRIPTION OF SOILS.

Experiments were carried out on the College farm and the farms of J. M. White and C. M. Housell, all located in Middlesex county.

The College farm was a heavy soil, a gravelly, clay loam, with a tight, red clay subsoil, and not specially adapted for potatoes. It had been in alfalfa since 1887, and was heavily manured in that year. There had also been applied upon it about 500 pounds per acre of a high-grade chemical manure in 1888 and 1889.

The plot on the farm of Mr. White consisted of a medium sandy loam, dry, open subsoil, in a good state of fertility. It had been heavily manured for cabbage in the previous season, and was well adapted for potatoes.

The soil of the farm of Mr. Housell was a light, sandy loam; had been subjected to the ordinary farm rotation, namely, corn, oats, wheat and grass, with manure once in rotation, and was of rather medium fertility. It had received about 10 loads of stable manure per acre for corn in 1889.

The varieties planted were the Early Rose in the experiments of the College farm and Mr. White, and the Burbank in that of Mr. Housell.

Each experiment occupied fourteen plots, each one-twentieth of an acre in area, the shape of the plots differing somewhat on the different farms owing to the varying conditions.

I.

CONSIDERATION OF YIELD.

The accompanying table shows the number of plots, the amount and kind of fertilizer used, and the yield per plot:

TABLE I.

Number of Plot.	KIND OF FERTILIZER.	Quantity per Plot.	COLLEGE FARM. POUNDS PER PLOT. Large.	Small.	Total.	J. M. WHITE. POUNDS PER PLOT. Large.	Small.	Total.	C. M. HOUSELL. POUNDS PER PLOT. Large.	Small.	Total.
1	Unfertilized	....	400	79	479	386	45	431	140	100	240
2	Bone Black Muriate of Potash	16 lbs. 8 "	435	84	519	542	12	551	425	103	528
3	Nitrate of Soda Bone Black Muriate of Potash	10 " 16 " 8 "	425	73	498	539	23	562	440	83	523
4	Nitrate of Soda Bone Black Sulphate of Potash	10 " 16 " 8 "	341	68	409	542	17	559	425	53	478
5	Nitrate of Soda Bone Black Kainit	10 " 16 " 32 "	276	38	314	463	17	480	350	78	428
6	Bone Black Sulphate of Potash	16 " 8 "	397	48	445	443	21	464	375	40	415
7	Unfertilized	....	425	72	497	364	28	392	148	40	188
8	Nitrate of Soda Bone Black Muriate of Potash	10 lbs. 16 " 8 "	514	58	572	544	22	566	410	20	430
9	Nitrate of Soda Bone Black Sulphate of Potash	10 " 16 " 8 "	405	157	562	532	25	557	450	42	492
10	Nitrate of Soda Bone Black Kainit	10 " 16 " 32 "	405	34	439	505	19	524	275	30	305
11	Bone Black Kainit	16 " 32 "	415	118	533	458	13	471	250	32	282
12	Barn-yard Manure	1 ton.	521	90	611	420	27	447	400	30	430
13	Barn-yard Manure Nitrate of Soda Bone Black Sulphate of Potash	1000 lbs. 5 " 8 " 4 "	550	68	618	572	36	608	525	50	575
14	Unfertilized	....	407	99	506	414	24	438	180	55	235
15	*Kainit Precipitated Phosphate	50 lbs. 25 "	......	....	....	521	20	541	....	....	......
16	†Reese's King Philip	25 "	....	....	....	....	......	....	375	113	488

*Applied in Mr. White's experiment. †Applied in Mr. Housell's experiment.

FIELD RECORD.

The potatoes were planted during the last week in April. The seed was cut to two eyes, and was placed from 12 to 15 inches apart in the rows. The furrowing was, in all cases, 2 feet 6 inches. In the experiments of Mr. White and the College farm the potatoes were planted, lightly covered, and the fertilizer then spread evenly over about one foot of the row, when they were covered to the depth of about 5 inches. In the experiment of Mr. Housell the fertilizer was distributed in the same manner, after which the potatoes were dropped and covered by an Aspinwall planter. The condition of the soil was good in all cases, and the cultivation such as to keep the ground loose and free from weeds.

Observations taken on June 14th showed the plants on the blank plots much smaller than on the fertilized plots, though uniform in size. The vines on the plots with mineral elements without nitrogen, though quite as large, were much lighter in color than those with complete chemical fertilizers or barn-yard manure. All came up well except on the kainit plots.

On July 4th the vines on the blank plots were very much smaller than on the fertilized plots. Of the plots 2, 6 and 11, without nitrogen, No. 2 had the finest and best-looking vines. Plots 3, 8 and 13 had the best-looking and largest vines, and 5, 10 and 11 the smallest and lightest-colored.

The crops were dug at the convenience of the farmers, at which time the potatoes were weighed and five-pound samples taken for analysis. The first point of study is:

THE RELATIVE EFFECT OF THE DIFFERENT METHODS OF FERTILIZING.

It will be observed that three plots were left unmanured in each experiment, in order to test the uniformity and productiveness of the soil. On nine plots chemical manures were used; one received barn-yard manure alone, and one barn-yard manure in connection with a complete chemical manure.

The yield of the unfertilized plots was quite uniform in each of the experiments, and in each case the average yield of the three plots

would probably fairly represent the average fertility of the land; it is, therefore, made the basis for comparing the relative effects of the different treatments.

While the average yield per plot on unmanured land is widely different on the three farms, the highest, 494 pounds, being on the College farm, 420 pounds on the farm of Mr. White, and the lowest, 223 pounds, on the farm of Mr. Housell, or a difference between highest and lowest of 271 pounds per plot. The best yield secured from the use of manures is on plot 13 in each case, and is remarkably uniform for all the experiments, the difference between highest and lowest being only 43 pounds.

The amount of plant-food applied was practically identical in each experiment, yet on the farm of Mr. Housell it increased the yield 352 pounds, or 158 per cent., on Mr. White's farm 188 pounds, or 45 per cent., and on the College farm but 117 pounds, or 24 per cent. The limit of production seems, therefore, to have been fixed by conditions other than the amounts of applied plant-food.

The conditions of soil, season, variety, cultivation, etc., seem to have fixed the maximum production in each case at about 200 bushels per acre. With the exception of soil these conditions were, as far as known, practically uniform. Hence, it is shown that the *amount* of supplied plant-food did not measure the increased yield.

Another point of interest is the effect of manures upon the size of the potatoes. In Mr. White's experiment the small potatoes on the unmanured land were 7.6 per cent. of the average total yield, and but 3.4 per cent. of the 25 per cent. greater average yield of the fertilized land. In Mr. Housell's experiment the effect of fertilizers was still more marked. The small potatoes on the unmanured land were 30 per cent. of the average yield, and but 11.6 per cent. of the 96 per cent. greater average yield of the fertilized land. On the College farm the effect upon size was also noticeable, though the yield was not increased by the use of fertilizers.

The effect of the different fertilizers is more clearly shown in Table II., where the yield and value of the three crops are compared on the basis of an acre. The price used in computing values was that at which merchantable potatoes were sold at time of digging, viz., 75 cents per bushel. The small potatoes were rated at 40 cents. The average weight per measured bushel at time of picking was 60 pounds, and all calculations were made on that basis.

TABLE II.

College Farm.

Number of Plot.	KIND OF FERTILIZER.	Quantity per Acre.	Cost per Acre.		Bushels per Acre. Large.	Small.	Total.	Total Value of Crop.	Net Value of Crop.	Gain or Loss.
1......	Unfertilized..................	....	....		133.3	26.3	159.6	$110 50	$110 50	....
2...	Bone Black.................. Muriate of Potash.........	320 lbs... 160 " ...	$4 10 3 60	$7 70	145.0	28.0	173.0	119 95	112 25	—$1 48
3...	Nitrate of Soda............ Bone Black.................. Muriate of Potash.........	200 " ... 320 " ... 160 " ...	4 64 4 10 3 60	12 34	141.6	24.3	165.9	115 92	103 58	—10 15
4...	Nitrate of Soda............ Bone Black.................. Sulphate of Potash......	200 " ... 320 " ... 160 " ...	4 64 4 10 4 80	13 54	113.6	22.6	136.2	94 24	80 70	—33 03
5...	Nitrate of Soda............ Bone Black.................. Kainit.........................	200 " ... 320 " ... 640 " ...	4 64 4 10 3 60	12 34	92.1	12.5	104.6	74 08	61 74	—51 99
6...	Bone Black.................. Sulphate of Potash......	320 " ... 160 " ...	4 10 4 80	8 90	132.3	16.0	148.3	105 63	96 73	—17 00
7......	Unfertilized..................	....	....		141.6	24.0	165.6	115 80	115 80	....
8...	Nitrate of Soda............ Bone Black.................. Muriate of Potash.........	200 lbs... 320 " ... 160 " ...	4 64 4 10 3 60	12 34	171.3	19.3	190.6	136 20	123 86	+10 13
9...	Nitrate of Soda............ Bone Black.................. Sulphate of Potash......	200 " ... 320 " ... 160 " ...	4 64 4 10 4 80	13 54	135.0	52.3	187.3	122 17	108 63	—5 10
10...	Nitrate of Soda............ Bone Black.................. Kainit.........................	200 " ... 320 " ... 640 " ...	4 64 4 10 3 60	12 34	135.0	11.3	146.3	106 77	93 43	—20 30
11...	Bone Black.................. Kainit.........................	320 " ... 640 " ...	4 10 3 60	7 70	138.3	39.3	177.6	119 45	111 75	—1 98
12	Barn-yard Manure.......	20 tons.	30 00		178.6	30.0	208.6	142 20	112 20	—1 53
13...	Barn-yard Manure....... Nitrate of Soda............ Bone Black.................. Sulphate of Potash......	10 " 100 lbs... 160 " ... 80 " ...	15 00 2 32 2 05 2 40	21 77	183.3	22.6	205.9	146 52	124 75	+11 02
14......	Unfertilized..................	....	....		135.6	33.0	168.6	114 90	114 90	....

TABLE II.—Continued.

J. M. White.

Number of Plot.	KIND OF FERTILIZER.	Quantity per Acre.	Cost per Acre.		Bushels Acre Large.	Bushels Acre Small.				
1	Unfertilized	....	....		128.6	15.0	143.6	$102 45	$102 45	....
2	Bone Black Muriate of Potash	320 lbs... 160 " ...	$4 10 3 60	$7 70	180.6	4.0	184.6	137 05	129 35	$28 07
3	Nitrate of Soda Bone Black Muriate of Potash	200 " ... 320 " ... 160 " ...	4 64 4 10 3 60	12 34	179.6	7.6	187.2	137 74	125 40	24 12
4	Nitrate of Soda Bone Black Sulphate of Potash	200 " ... 320 " ... 160 " ...	4 64 4 10 4 80	13 54	180.6	5.6	186.2	137 69	124 15	22 87
5	Nitrate of Soda Bone Black Kainit	200 " ... 320 " ... 640 " ...	4 64 4 10 3 60	12 34	154.3	5.6	159.9	117 97	105 63	4 35
6	Bone Black Sulphate of Potash	320 " ... 160 " ...	4 10 4 80	8 90	147.6	7.0	154.6	113 50	104 60	3 32
7	Unfertilized	....	....		121.3	9.3	130.6	94 70	94 70	....
8	Nitrate of Soda Bone Black Muriate of Potash	200 lbs... 320 " ... 160 " ...	4 64 4 10 3 60	12 34	181.3	7.3	188.6	138 90	126 56	25 28
9	Nitrate of Soda Bone Black Sulphate of Potash	200 " ... 320 " ... 160 " ...	4 64 4 10 4 80	13 54	177.3	8.3	185.6	136 30	122 76	21 48
10	Nitrate of Soda Bone Black Kainit	200 " ... 320 " ... 640 " ...	4 64 4 10 3 60	12 34	168.3	6.3	174.6	128 74	116 40	15 12
11	Bone Black Kainit	320 " ... 640 " ...	4 10 3 60	7 70	152.6	4.3	156.9	116 17	108 47	7 19
12	Barn-yard Manure	20 tons.	30 00		140.0	9.0	149.0	108 62	78 62	—22 66
13	Barn-yard Manure Nitrate of Soda Bone Black Sulphate of Potash	10 " 100 lbs... 160 " ... 80 " ...	15 00 2 32 2 05 2 40	21 77	190.6	12.0	202.6	147 75	125 98	24 70
14	Unfertilized	....	....		138.0	8.0	146.0	106 70	106 70	....
15	*Kainit Precipitated Phosphate	1000 lbs. 500 "	13 50		173.6	6.6	180.2	132 84	119 34	13 06

*Applied in Mr. White's experiment.

TABLE II.—Continued.

C. M. Housell.

Number of Plot.	KIND OF FERTILIZER.	Quantity per Acre.	Cost per Acre.	BUSHELS PER ACRE. Large.	Small.	Total.	Total Value of Crop.	Net Value of Crop.	Gain or Loss.
1......	Unfertilized..............	....	....	46.6	33.3	79.9	$48 27	$48 27	....
2...	Bone Black................. Muriate of Potash........	320 lbs... 160 " ...	$4 10 3 60 } $7 70	141.6	34.3	175.9	119 92	112 22	$65 01
3...	Nitrate of Soda............ Bone Black................. Muriate of Potash........	200 " ... 320 " ... 160 " ...	4 64 4 10 } 12 34 3 60	146.6	27.6	174.2	120 99	108 65	61 44
4...	Nitrate of Soda............ Bone Black................. Sulphate of Potash......	200 " ... 320 " ... 160 " ...	4 64 4 10 } 13 54 4 80	141.6	17.6	159.2	113 24	99 70	52 49
5...	Nitrate of Soda............ Bone Black................. Kainit.........................	200 " ... 320 " ... 640 " ...	4 64 4 10 } 12 34 3 60	116.6	26.0	142.6	97 85	85 51	38 30
6...	Bone Black................. Sulphate of Potash......	320 " ... 160 " ...	4 10 4 80 } 8 90	125.0	13.3	138.3	99 07	90 17	42 96
7......	Unfertilized..............	....	....	47.6	13.3	60.9	41 02	41 02	....
8...	Nitrate of Soda............ Bone Black................. Muriate of Potash........	200 lbs... 320 " ... 160 " ...	4 64 4 10 } 12 34 3 60	136.6	6.6	143.2	105 09	92 75	45 54
9...	Nitrate of Soda............ Bone Black................. Sulphate of Potash......	200 " ... 320 " ... 160 " ...	4 64 4 10 } 13 54 4 80	150.0	14.0	164.0	118 10	104 56	57 35
10...	Nitrate of Soda............ Bone Black................. Kainit.........................	200 " ... 320 " ... 640 " ...	4 64 4 10 } 12 34 3 60	91.6	10.0	101.6	72 70	60 36	13 15
11...	Bone Black................. Kainit.........................	320 " ... 640 " ...	4 10 3 60 } 7 70	83.3	10.6	93.9	66 72	59 02	11 81
12......	Barn-yard Manure......	20 tons.	30 00	133.3	10.0	143.3	103 98	73 98	26 77
13...	Barn-yard Manure...... Nitrate of Soda............ Bone Black................. Sulphate of Potash......	10 " 100 lbs... 160 " ... 80 " ...	15 00 2 32 2 05 } 21 77 2 40	175.0	16.6	191.6	137 89	116 12	68 91
14......	Unfertilized..............	....	....	60.0	18.3	78.3	52 32	52 32	....
16......	*Reese's King Philip...	500 " ...	7 00	125.0	37.5	162.5	108 75	101 75	54 54

*Applied in Mr. Housell's experiment.

Regarding the average yield of the nine plots fertilized with chemical manures as representing one method of manuring, the yield and value of the product on the unmanured land may be compared with that from three methods: 1. Barn-yard manure alone; 2. Chemical manures alone; and, 3. Barn-yard and chemical manures together.

The net value of the crop on the different plots is derived by deducting the cost of the manure used.

TABLE III.

College Farm.

AVERAGE ON PLOTS.	Cost of Fertilizer.	Yield per Acre.	Value.	Net Value.	Gain or Loss.
Nos. 1, 7, 14	....	bu. 164.6	$118 78	$118 78	....
No. 12	$30 00	203.6	142 20	112 20	—$1 58
Nos. 2, 3, 4, 5, 6, 8, 9, 10, 11	11 19	158.9	110 38	99 19	—14 54
No. 13	21 77	205.9	146 52	124 75	11 02

J. M. White.

AVERAGE ON PLOTS.	Cost of Fertilizer.	Yield per Acre.	Value.	Net Value.	Gain or Loss.
Nos. 1, 7, 14	....	bu. 140.0	$101 28	$101 28	....
No. 12	$30 00	149.0	108 62	78 62	—$22 66
Nos. 2, 3, 4, 5, 6, 8, 9, 10, 11	11 19	175.2	129 34	118 15	16 87
No. 13	21 77	202.6	147 75	125 98	24 70

C. M. Housell.

AVERAGE ON PLOTS.	Cost of Fertilizer.	Yield per Acre.	Value.	Net Value.	Gain or Loss.
Nos. 1, 7, 14	....	bu. 73.0	$47 19	$47 19	....
No. 12	$30 00	143.3	103 98	73 98	$26 79
Nos. 2, 3, 4, 5, 6, 8, 9, 10, 11	11 19	143.6	101 52	90 33	43 14
No. 13	21 77	191.6	137 89	116 12	68 93

A study of the table shows that the application of 200 pounds of nitrogen, 200 of phosphoric acid and 100 of potash in 20 tons of barn-yard manure per acre, was followed by the *lowest yield* in all cases, and was profitable *only* on the farm of Mr. Housell; that an

average application of 20 pounds of nitrogen, 50 of phosphoric acid, and 80 of potash in the form of complete chemical manures, was profitable on two farms, and that a combination of one-half of the barn-yard manure and one-half of the chemical manure used in the other methods *gave the largest yield and was profitable in all cases.* It would seem, therefore, that neither the *total quantity of plant-food nor the rate of availability, is a measure of the profitable increase in yield from the use of manures,* since the largest total amount was applied on the barn-yard manure plots, and the largest available amount was applied on the plots fertilized with chemical manures. This result is in accord with that previously noted, and indicates that the physical character of the soil, or conditions other than the presence of a sufficiency of plant-food, exercise a very marked influence on yield.

While in two experiments the net profit per acre from the use of chemical manures alone was large, reaching $43.14 per acre in the experiment of Mr. Housell, the results on plots 15 and 16, adjoining the experiment plots, and which represents the methods of manuring of Mr. White and Mr. Housell, show that the quantity and kind of plant-food applied are important considerations in determining net profits.

In the case of Mr. White, plot 15 received potash in the form of kainit at the rate of 1,000 pounds, and precipitated phosphate 500 pounds per acre. These furnished 125 pounds of actual potash and 150 pounds of available phosphoric acid, at a cost of $13.50. The yield was 180.2 bushels, with a net profit of $18.06. On plot 2, with an application of 80 pounds of available phosphoric acid from bone-black superphosphate, and 80 pounds of actual potash from muriate, together costing $7.70, the yield was 184.6 bushels, with a net profit of $28.07. On plots 3 and 8, where the same amounts of phosphoric acid and potash were used in connection with nitrogen, the average net profit is $24.70, or less by about the cost of the nitrogen used. Mr. White's method of fertilizing, while profitable, was $10.01 per acre less profitable than the method used on plot 2.

In the experiment of Mr. Housell, plot 16 received an application of King Phillip fertilizer, at the rate of 500 pounds per acre, costing $7, and furnishing 6 pounds of nitrogen, 32 of phosphoric acid and 15 of potash. The yield was 162.5 bushels, and net profit $54.54. The yield on plot 2 was 175.9 bushels, with a net profit of $65.01, or greater by $10.47 than was secured by the general practice of Mr. Housell.

In the one case, from an excess of applied plant-food, the actual profit was $10.01 less than the maximum possible under the existing circumstances. In the other it was $10.47 less, from a deficiency.

The second question to be considered is:

THE EFFECT OF THE DIFFERENT FORMS OF POTASH SALTS.

In each experiment, *duplicate plots*, treated with different forms of potash, also received available phosphoric acid and nitrogen, and one plot in each experiment a different form of potash in connection with phosphoric acid only.

The yields from the duplicate plots in each experiment were reasonably uniform, and were not appreciably greater than where mineral elements were used without nitrogen. Hence, the nine plots treated with mineral fertilizers may be combined into three groups, each treated alike, the average yield of which may properly represent the effect of the different forms of potash salts, as follows:

	COLLEGE FARM. Yield per acre.	WHITE. Yield per acre.	HOUSELL. Yield per acre.
Muriate of Potash	176.5 bushels.	186.7 bushels.	164.4 bushels.
Sulphate of Potash	157.2 "	175.8 "	153.8 "
Kainit	142.8 "	163.8 "	112.7 "

On the farms of Mr. Housell and Mr. White, the yield from the use of the muriate is 6 per cent. greater than from the sulphate. On the College farm the average increased yield from the use of sulphate was but 4 per cent., while from the muriate it was about 8 per cent. These differences would be too slight to warrant any conclusions if it were not that a pound of actual potash in the form of sulphate now costs 33 per cent. more than a pound in the form of muriate. The kainit was the least effective, and in a few cases proved an injury. This is believed to be due to the fact that the necessarily larger bulk used may not have been sufficiently distributed to secure perfect solution. Both the sulphate and kainit are less readily soluble than the muriate, and an application of either in the previous fall or very early spring, in order to allow of complete solution and distribution, would doubtless have made the yields from the different farms even more uniform. The belief that sulphates are more valuable than muriates is not borne out by the results secured under the conditions of these experiments.

THE EFFECT OF NITRATE OF SODA.

Nitrate of soda, used either alone or in two applications, seems to have been practically without effect. Nitrate of soda is the most readily available form of nitrogen. It was applied on six plots, plentifully supplied with the mineral elements, phosphoric acid and potash; on three plots at the time of planting, and on three others both at the time of planting and again a month later, when the plants were through the ground and in a condition to rapidly assimilate plant-food. The reason for its failure to aid in the production of the crop is not clear, since the general experience of both experimenters and practical farmers is that uniformly good results have followed its use upon potatoes. The character of the season, which was warm, moist and favorable for the formation of nitrates, may, however, have produced such conditions as to enable the plants to secure their full supply from the soil. Mr. White, who has carefully studied his soil, has, for a number of years, used only phosphoric acid and potash for potatoes, having reached the conclusion that he received no benefit on this crop from the use of nitrogen in any form.

CONCLUSIONS.

These experiments would seem to teach:

1. That it pays to use commercial fertilizers for potatoes.
2. That the best results are secured when chemical manures are used in connection with barn-yard manure.
3. That when prices are the same, sulphate of potash presents no advantage over muriate.

Though something has been learned from these experiments, further study seems imperative, for there is no one question so important to the general farmer of this State as the study of soils and crops in regard to the economical use of manures.

II. CONSIDERATION OF CHEMICAL COMPOSITION.

The selling price of potatoes is governed in a certain measure by their reputation in the market, and market conditions are such as to

make this reputation depend not so much on their actual quality or food-value, as upon their size, uniformity and general appearance. Yet there are certain varieties which, while they conform to market requirements in these respects, rule low in price, because they have the reputation of boiling heavy, and are therefore of poor quality. While this is a characteristic of certain varieties, "boiling heavy" sometimes depends upon the quality of the cook rather than upon that of the potato. It is also a well-known fact that the same varieties grown in different sections are quoted at different prices, showing that soil and climate conditions, or methods of marketing, influence values. For instance, the New York market reports always specify whether from Long Island, New Jersey, Maine or State, with a range in selling price of from 25 to 50 cents per barrel, which is, at present prices, from 10 to 15 per cent. on the value per barrel.

These are the facts, and whatever may be the true cause, it is to the farmer's interest to cater to public demand. In this State, where large quantities of commercial fertilizers are used, farmers have been told that potash is the chief element of plant-food for potatoes, and that the high-grade sulphate, or the double sulphate of potash and magnesia, has been proved to be much better than the muriate, or chloride, or the low-grade salts in the form of kainit, since the latter, while they might be quite as effective in promoting the growth of the potatoes, have a tendency to decrease their content of starch, causing them to boil heavy and soggy, and be correspondingly less salable. Acting on this general belief, the larger number of special potato fertilizers now prepared contain a high per cent. of potash in the form of sulphate.

In Section I. of this bulletin it has been shown that in these experiments the yield from the use of muriate was quite as high as from the sulphate, which cost 33 per cent. more. If the content of starch determines quality, and quality governs price, as is assumed, there would be a loss to the farmer from the use of sulphate, unless it materially increased the content of starch.

The objects of this chemical examination were:

1. To study the direct effect of the different forms of potash salts upon the chemical composition of the potato.

2. To study the variation in composition of potatoes of the same and different varieties, in reference both to their food compounds and fertilizing elements.

Samples were taken and weighed as soon as they were dug. No appreciable loss of weight was noticed a few weeks later, when they were prepared for analysis as follows: From seven to eight potatoes of average size, each weighing approximately 100 grams, were washed and sliced, and then dried in an evaporator at a temperature of 60° C. The analyses published were made on the dry sample according to the methods prescribed by the Association of Official Agricultural Chemists.

To check the percentage of carbo-hydrates secured by difference, starch determinations, according to Sachsse's method, were made in single potatoes from each plot. The results from the two methods were relatively the same and agreed with each other quite as closely as could be expected from determinations on different samples by the same method. The former determinations are therefore used to indicate the percentage of starch.

TABLE I.

Chemical Analyses of the Potatoes from the Different Plots of the Three Experiments.

College Farm.

Station Number.	Number of Plot.	POUNDS PER HUNDRED OF					
		Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Starch.
511	1	77.714	0.081	0.386	2.460	0.841	18.518
512	2	79.512	0.073	0.334	2.180	0.898	17.003
513	3	80.280	0.090	0.351	2.171	0.869	16.239
514	4	78.553	0.067	0.380	2.478	0.820	17.702
515	5	81.126	0.072	0.355	1.998	1.015	15.434
516	6	79.192	0.068	0.350	2.311	0.822	17.257
517	7	78.206	0.082	0.370	2.284	0.748	18.310
518	8	79.642	0.059	0.315	2.339	0.797	16.848
519	9	79.053	0.062	0.382	2.326	0.808	17.369
520	10	81.075	0.095	0.402	2.151	0 810	15.467
521	11	80.656	0.056	0.334	2.293	0.859	15.802
522	12	79.686	0.066	0.389	2.134	0.858	16.922
523	13	79.250	0.068	0.363	2.220	0.898	17.201
524	14	78.250	0.080	0.364	2.243	0.784	18.279

TABLE I.—Continued.

Chemical Analyses of the Potatoes from the Different Plots of the Three Experiments.

J. M. White.

Station Number.	Number of Plot.	Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Starch.
		POUNDS PER HUNDRED OF					
525	1	77.855	0.069	0.479	1.680	0.957	18.960
526	2	79.408	0.072	0.398	1.565	0.976	17.581
527	3	77.881	0.090	0.448	1.659	0.988	19.434
528	4	77.334	0.086	0.440	1.994	0.958	19.193
529	5	79.357	0.074	0.457	1.741	0.900	17.471
530	6	78.865	0.076	0.421	1.854	1.020	17.764
531	7	77.862	0.074	0.461	1.718	0.928	18.957
532	8	78.089	0.068	0.371	2.246	0.757	18.469
533	9	76.833	0.086	0.406	2.218	0.845	19.612
534	10	80.248	0.079	0.390	1.792	0.888	16.608
535	11	79.390	0.088	0.456	1 601	1.069	17.396
536	12	77.787	0.081	0.449	1.799	0.919	19.015
537	13	78.571	0.088	0.478	2.014	0.894	17.965
538	14	75.819	0.080	0.418	2.128	0.967	20.588

C. M. Housell.

Station Number.	Number of Plot.	Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Starch.
541	1	78.684	0.045	0.306	2.444	0.722	17.808
540	2	79.692	0.078	0.396	2.262	0.680	16.897
543	3	81.473	0.035	0.312	2.122	0.721	15.337
542	4	80.051	0.048	0.347	2.377	0.738	16.439
544	5	81.153	0.047	0.359	2.281	0.677	15.483
545	6	78.121	0.069	0.357	2.289	0.743	18.421
546	7	78.648	0.042	0.371	2.172	0.604	18.163
547	8	80.063	0.049	0.344	1.998	0.693	16.853
548	9	79.777	0.076	0.341	2.345	0.761	16.700
549	10	80.884	0.044	0.347	1.669	0.800	16.256
550	11	81.115	0.044	0.385	1.664	0.711	16.189
551	12	79.559	0.056	0.356	1.881	0.713	17.435
552	13	80.841	0.047	0.391	1.942	0.859	15.920

TABLE II.

College Farm.

	AVERAGE PERCENTAGE OF						
	Dry Matter.	Starch.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Dry Matter, Not Including Starch.
Unfertilized	21.943	18.369	0.081	0.373	2.329	0.791	3.574
Sulphate	21.067	17.443	0.066	0.371	2.372	0.817	3.626
Muriate	20.189	16.697	0.074	0.333	2.230	0.855	3.492
Kainit	19.048	15.568	0.074	0.364	2.147	0 895	3.480
Fertilized	20.184	16.659	0.071	0.360	2.236	0.859	3.526

J. M. White.

Unfertilized	22.821	19.502	0.074	0.453	1.842	0.951	3.320
Sulphate	22.323	18.856	0.083	0.422	2.022	0.939	3.466
Muriate	21.707	18.495	0.077	0.406	1.823	0.907	3.213
Kainit	20.335	17.158	0 080	0.434	1.711	0.951	3.176
Fertilized	21.526	18.228	0.080	0.428	1.862	0.928	3.298

C. M. Housell.

Unfertilized	21.359	17.983	0.067	0.339	2.308	0.663	3.377
Sulphate	20.684	17.187	0.064	0.348	2.337	0.747	3.496
Muriate	19.591	16.362	0.052	0.351	2.127	0.698	3.228
Kainit	18.949	15.976	0.045	0.347	1.852	0.729	2.973
Fertilized	19.752	16.539	0.053	0.353	2.070	0.736	3.212

Experiments made to determine the influence of nitrate of soda upon the starch in potatoes, have shown that it does not preceptibly change its amount. It is therefore possible in each experiment to compare the average analysis of the potatoes on the unfertilized plots with the average on the three plots in each experiment treated with the different forms of potash, and also with the average analysis on all the fertilized plots.

Except in the case of water and starch, which the analyses show to vary considerably, both in the same and in different varieties, the chemical composition of the potatoes from the different plots is quite as uniform as could be expected from different samples from the same plot. Table II. shows, therefore, whether the variations in the percentage of water and starch in the potato may be attributed to methods of fertilization or to accident.

This tabulation clearly shows that the effect of manures, whether considered as a whole or with reference to the form of potash used, was to reduce the amount of dry matter in the potato, and that the changes in dry matter were accompanied by corresponding changes in the compound carbo-hydrates.

The relative effect of the different forms of potash salts upon these compounds is further brought out in the following table, where the actual decrease in dry matter due to the different treatments is tabulated for comparison:

TABLE III.

DECREASE DUE TO		COLLEGE FARM.		J. M. WHITE.		C. M. HOUSELL.	
		Pounds per Hundred.	Percentage.	Pounds per Hundred	Percentage.	Pounds per Hundred.	Percentage.
Sulphate.	in Dry Matter	0.87	4.0	0.50	2.2	0.68	3.2
	in Starch.....	0.93	5.1	0.64	3.3	0.79	4.4
Muriate..	in Dry Matter	1.75	8.0	1.11	4.9	1.77	8.3
	in Starch......	1.67	9.1	1.00	5.1	1.62	9.0
Kainit.....	in Dry Matter	2.89	13.2	2.48	10.9	2 41	11.3
	in Starch......	2.80	15.2	2.34	12.0	2.00	11.1

The results from all the experiments agree very closely with each other, though a very marked difference is noticed in the effect of the different forms of potash. It has already been shown that manures, grouped either according to the form of potash or as a whole, did unfavorably influence the percentage of dry matter in the potato. The above tabulation shows that of the three forms of potash used, the sulphate was the least unfavorable, since it reduced the dry matter in the average of all the experiments but 0.68 pounds in 100 pounds of potatoes, or 3.1 per cent., and that the kainit was the most unfavorable, and on the same basis reduced the dry matter by 2.59 pounds, or 11.8 per cent.; the effect of the muriate corresponding to the average general effect. It is also shown that the starch was affected by the different kinds of potash in the same relative proportion as the dry matter.

The teachings of these experiments do, therefore, accord with the opinions now generally held, and based upon previous experiments, namely, that potash does influence the composition of potatoes, and that, of the different commercial forms, the *sulphate* is the *most valuable.*

It was a subject of remark at the time of digging that the potatoes on the sulphate plots, while not so large, were more uniform in size and of smoother skin than those on the plots fertilized with muriate, kainit or barn-yard manure.

As a matter of interest, and also to test whether differences indicated by analysis and appearance could be discerned by the appearance or taste of the cooked potato, single tubers of uniform size from each of the plots in Mr. Housell's experiment, which showed the widest difference by analysis, were boiled under exactly the same conditions. While all the potatoes were dry and mealy, the Chemists of the Station were unanimous in their choice of the potatoes grown on the plots treated with sulphate as showing superior quality, and persons entirely unacquainted with the facts who were asked to judge quality, selected without hesitation the potatoes grown on plots 4, 6 and 9.

The influence of manures on the composition of dry matter was also studied and comparisons similar to those in Table II. are here shown:

TABLE IV.

College Farm.

	Average percentage of				
	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Starch.
Unfertilized	0.369	1.703	10.610	3.604	83.716
Sulphate	0.312	1.759	11.255	3.877	82.797
Muriate	0.367	1.652	11.046	4.235	82.698
Kainit	0.391	1.911	11.269	4.700	81.728
Fertilized	0.351	1.784	11.081	4.268	82.515

J. M. White.

Unfertilized	0.326	1.991	8.049	4.171	85.463
Sulphate	0.370	1.895	9.048	4.227	84.461
Muriate	0.353	1.869	8.395	4.188	85.196
Kainit	0.395	2.137	8.425	4.671	84.358
Fertilized	0.373	1.993	8.644	4.323	84.663

C. M. Housell.

Unfertilized	0.312	1.585	10.806	3.104	84.194
Sulphate	0.311	1.686	11.324	3.619	83.060
Muriate	0.265	1.786	10.871	3.572	83.506
Kainit	0.237	1.831	9.779	3.846	84.305
Fertilized	0.269	1.790	10.478	3.735	83.727

It will be observed that the composition of the dry matter of the potatoes grown on the different farms varies considerably, while the average of those grown under the treatment with different manures agreed within the limits of error in all compounds, except crude protein, which is slightly higher in the potatoes from the plots treated with sulphate in all the experiments. The effect of this change in composition would be to increase actual food-value, if all the nitrogen was in the form of albuminoids. Determinations made by Stutzer's method showed, however, that but 50 per cent. of the total nitrogen was in the form of albuminoid. The influence of this compound on the general idea of quality might, therefore, not be noticeable.

STUDY OF PLANT-FOOD ELEMENTS.

In addition to ash and nitrogen, the mineral elements, phosphoric acid and potash, were determined in each sample. As in the composition of food compounds, the variations in the amounts of plant-food elements contained were not marked in the samples from the different plots in each experiment.

Table V. shows the average plant-food analyses of potatoes from each experiment, both in the original sample and calculated to water-free basis.

TABLE V.

EXPERIMENT.	IN ORIGINAL SAMPLE.				IN WATER—FREE SAMPLE.			
	Nitrogen.	Ash.	Phosphoric Acid.	Potash.	Nitrogen.	Ash.	Phosphoric Acid.	Potash.
College Farm	0.361	0.844	0.125	0.441	1.756	4.126	0.608	2 156
J. M. White	0.297	0.932	0.113	0.513	1.363	4.291	0.517	2.360
C. M. Housell	0.337	0.725	0.120	0.386	1.685	3.638	0.561	1.938

Noticeable variations exist between the same and different varieties. The average composition of the whole is shown to be 0.33 per cent. nitrogen, 0.12 per cent. phosphoric acid and 0.45 per cent. potash. On the basis of this average analysis, the highest yield, 200 bushels,

or 12,000 pounds, would remove 39.8 pounds of nitrogen, 13.9 of phosphoric acid and 53.8 of potash. No analyses of the vines were made, but according to the best authority we have, the amount of vine accompanying this yield would contain approximately 1,000 pounds of dry matter, in which there would be 20 pounds of nitrogen, 3 of phosphoric acid and 4 of potash, making the total plant-food removed by this crop, 59.8 pounds of nitrogen, 16.9 of phosphoric acid and 57.8 of potash. On the same basis of analyses the average crop from the unmanured land in each experiment secured from the soil the following amounts of plant-food:

	Nitrogen.	Phosphoric Acid.	Potash.
College Farm	49.3	13.9	47.6
J. M. White	41.9	11.9	40.5
C. M. Housell	21.9	6.2	21.1

The differences between these amounts and those actually secured by the highest yield are, for each experiment, the following:

	Nitrogen.	Phosphoric Acid.	Potash.
College Farm	10.5	3.0	10.2
J. M. White	17.9	5.0	17.3
C. M. Housell	37.9	10.7	36.7

The plots receiving a complete fertilizer were dressed with an equivalent of 800 pounds of a high-grade potato fertilizer, containing 4 per cent. nitrogen, 6.4 per cent. available phosphoric acid and 10 per cent. potash, or 32 pounds of nitrogen, 51.2 of phosphoric acid and 80 of potash. Assuming that all the plant-food elements in the increased crop in each case were secured from that supplied in the fertilizer, there remains the following amounts of these elements to the credit of increased fertility:

	Nitrogen.	Phosphoric Acid.	Potash.
College Farm	21.5	49.2	69.8
J. M. White	14.1	47.2	62.7
C. M. Housell	—5.9	41.5	43.3

This result verifies from another standpoint the teachings of the preceding section, namely, that in these experiments conditions other than plant-food supplied marked the limit of increase in crop.

FIELD EXPERIMENTS WITH FERTILIZERS ON WHEAT.

In studying the effects of manure upon the different crops, two important considerations should be kept in mind, viz.: 1. The increased yield. 2. Its value.

Where produce is of such a character as to bring a relatively high price, as vegetables, fruits, etc., the proper use of manures is often followed by very large profits; whereas the contrary may be the case when the increased products are of relatively low value, as wheat, hay, etc., though the plant-food applied may have been used quite as economically in the one case as in the other. Our own experiments have shown that an application of certain kinds of plant-food, while not producing the full effect, resulted in a profit of $126.86 with tomatoes, and $68.91 with potatoes. The same quantity and kind of fertilizer applied on such crops as wheat, hay or oats, though producing their full effect, could not possibly increase the crop to such a degree as to admit of these large profits, because of the lower value of the produce.

To the farmer raising produce of the lower value, the second point is of the utmost importance. It has been clearly established that, under the conditions of labor, price of land, taxation, etc., which now exist in the Eastern States, it does not pay to raise twelve bushels of wheat per acre and sell it for $1 per bushel, and, while it is admitted that the yield may be increased by the use of manures, that it can be done at a profit is by no means certain. It is obvious that all the grain and stock farmers in the State could not change their methods to adopt those of the market-gardener or fruit farmer. Therefore, since wheat must be raised, any study which will aid in its more profitable production must be of advantage. According to the best knowledge we have, wheat requires for its normal development a full supply of nitrogen throughout its period of growth. Since this is the most costly element of plant-food, it follows, naturally, that with the wheat crop the greatest care should be exercised in its use.

The experiments conducted this year were planned to study the effect of nitrogen as nitrate of soda, when used either alone or when used in connection with either one or both of the elements, potash and phosphoric acid.

Experiments were carried out under the direction of the Station,

on the farms of John Voorhees, South Branch, Somerset county; H. H. Hight, Raritan, Somerset county, and the College farm, New Brunswick, Middlesex county.

EXPERIMENT OF JOHN VOORHEES.

The plots were 33 feet wide and 132 feet long, one-tenth of an acre in area, and were separated from each other by spaces one foot wide. The plots used were under experiment with oats in 1889. At that time plot 2 received 150 pounds of muriate of potash; plot 3, 300 pounds of bone-black superphosphate; plot 4, a mixture of the same kind and quantity as used on 2 and 3, and plots 1 and 5 were unmanured. The soil was a medium clay loam, level and well drained. In 1888, the field was planted in corn, and was fertilized with 150 pounds of muriate of potash per acre. It is not usual to fertilize for oats, hence plots 1 and 5 represented the general treatment of the land for wheat.

The bone-black superphosphate, muriate of potash and one-fourth of the nitrate of soda were applied broadcast at the time of seeding the wheat, on September 24th. The remainder of the nitrate was applied on April 29th, 1890. The wheat came up evenly and made a good top in the fall, and owing to the favorable winter, looked well in the spring. No difference in the appearance of the manured plots could be detected, though they were all better than plot 5. The experiment was visited on June 7th, at which time all the manured plots were far superior to plot 5; plot 4 appeared altogether the best; plots 1, 2 and 3 were quite uniform, with rank straw, green color and large heads. The aphis did not seriously injure the crop, though the damage from them was noticeable from the presence of shrunken grains at time of threshing. The crop was harvested the first week in July, and threshed and weighed July 24th.

The results of this experiment are considered from three standpoints:

1. *Yield and quality.*
2. *Financial profits.*
3. *Economical use of nitrogen in crop production.*

TABLE I.

Yields.

Number of Plot.	Fertilizer. Kind.	Fertilizer. Weight per Acre.	Fertilizer. Cost per Acre.	Yield per Acre. Pounds of Good Wheat.	Yield per Acre. Pounds of Poor Wheat.	Yield per Acre. Bushels of Good Wheat.	Yield per Acre. Bushels of Poor Wheat.	Yield per Acre. Pounds of Straw.	Weight per Measured Bushel of Wheat.	Pounds of Straw per Bushel of Wheat.
1	Nitrate of Soda	160 lbs.	$3 71	1,110	50	18.5	0.8	2,480	57.2	128.5
2	Nitrate of Soda Muriate of Potash	160 " 160 "	7 81	1,060	50	17.7	0.8	2,460	56.5	133.0
3	Nitrate of Soda Superphosphate	160 " 320 "	7 81	1,330	40	22.2	0.7	3,070	57.8	134.1
4	Nitrate of Soda Muriate of Potash Superphosphate	160 " 160 " 320 "	11 41	1,515	35	25.8	0.6	3,140	60.8	121.2
5	Unfertilized	....	....	760	35	12.7	0.6	1,555	57.1	116.9

TABLE II.

Chemical Analyses.

Number of Plot.	Pounds per hundred pounds of wheat. Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Carbo-hydrates.	Pounds per hundred pounds of straw. Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Carbo-hydrates.
1	10.61	2.26	2.19	13.78	1.88	69.28	6.41	1.11	39.53	3.50	4.08	45.37
2	10.57	2.12	2.28	13.74	1.79	69.50	5.94	1.67	37.83	3.41	4.70	46 95
3	12.17	1.98	2.22	12.19	1.79	69.65	6.34	1.64	38.05	3.52	4.53	45.92
4	12.11	1.94	2.25	11.95	1.78	69.97	6.18	1.40	39.44	3.22	4 82	44.94
5	11.70	1.98	2.22	13.03	1.81	69.26	6.72	1.48	37.74	3.29	4.70	46.07

The yield of oats on plots 1 and 5 in 1889 was very uniform, and that on plot 5 this year may be safely considered to represent the unmanured land.

COMPARISON OF YIELDS.

	WHEAT. Bushels.	STRAW. Pounds.
Unmanured land	12.7	1,555
Gain from nitrate of soda alone	5.8	925
" " " " " with potash	5.0	905
" " " " " " phosphoric acid	9.5	1,515
" " " " " " " " and potash	12.6	1,585
Increased gain due to phosphoric acid	3.7	590
" " " " " " and potash	6.8	660

It will be observed that while the nitrate alone increased the yield by 5.8 bushels, its best effect, 12.6 bushels of wheat and 1,585 pounds of straw, or an increase of 100 per cent., was secured only when there was a full supply of the mineral elements. The presence of these influenced the quality of the product, as is shown by the weight of measured bushel and by the amount of poor wheat, for on plot 4 there was but 0.6 bushels, or 2.4 per cent., of poor wheat, against 0.8 bushels, or 4.3 per cent., on plot 1, and 0.6 bushels, or 4.7 per cent., on the unmanured plot. The weight per measured bushel on plot 5 was above the legal standard. The weight of straw per bushel of wheat was also less on plot 4, as indicated by the table, the proportion of straw to wheat being greatest on plots 2 and 3. The quality of the wheat, as shown by analysis, seems to have been improved on plots 1 and 2, where nitrogen did not have its full effect. On plots 3 and 4, where the yield was the largest, and presumably a normal development, there was a perceptible decrease in the protein as compared with the unmanured land. The composition of the straw was not materially different on any of the plots.

FINANCIAL PROFITS.

Deducting the cost of the fertilizers, which is fixed at prices at which they can be secured by farmers at point of consumption, and calculating values on the basis of $1 per bushel for wheat and disregarding the straw, the following financial gains are obtained:

Nitrate of soda alone	$2.09 per acre.
" " " and potash	—2.31 " "
" " " " phosphoric acid	1.69 " "
" " " " " " and potash	1.19 " "

On this basis a decided gain is secured on plots 1, 3 and 4. Whether it is large enough to make the wheat crop pay is a question for the farmer to decide.

Calculating values on the basis of the present selling price for wheat, $1.10 per bushel, and fixing the value of straw at $5 per ton, which it is worth when properly used and which is less than market quotations, the profits are:

With nitrate of soda alone	$4.98	per acre.
" " " " and potash	.45	" "
" " " " " phosphoric acid	6.42	" "
" " " " " " " and potash	6.41	" "

On this basis there is profit in every case, the greatest profit accompanying the most effective use of nitrogen, and while the greatest gain is small in comparison with that which may be secured from the use of the same amounts of fertilizers on crops of higher value, it is still enough to pay interest and taxes on land at a valuation of $75 per acre.

In planning the experiment, advantage was taken of the results of previous experiments, which teach that nitrate is used to the best purpose when applied as a top-dressing. It was assumed that the fall growth could economically use the small amount applied at time of seeding.

In order to study how far the nitrate was used in the production of crop, the wheat and straw were carefully sampled at time of threshing, and a determination of the plant-food elements was included in the chemical analysis.

As shown in Table II., nitrogen, the basis of protein, was lower in those plots, 3 and 4, where the largest yield was secured. Of the other plant-food elements, potash is lower in wheat and higher in straw in the samples from plots 3 and 4; the phosphoric acid in the samples of wheat is uniform for all the plots.

Table III. shows both the kind and amount of plant-food applied and removed by the crops on the different plots; the amount contained in the increased yields, and the yield secured per pound of nitrogen used by the crop.

TABLE III.

Number of Plot.	Pounds of Plant-Food Applied per Acre.			Yield per Acre, in Pounds.	Pounds of Plant-Food Removed by Total Yield per Acre.			Increased Yield per Acre, in Pounds.	Pounds of Plant-Food Removed per Acre by Increased Yield.			Yield Secured per Pound of Nitrogen Used.	
	Nitrogen.	Phosphoric Acid.	Potash.		Nitrogen.	Phosphoric Acid.	Potash.		Nitrogen.	Phosphoric Acid.	Potash.	Wheat.	Straw.
1	25	......	......	Wheat, 1,160.. Straw, 2,480..	39.27	14.24	21.52	Wheat, 365.. Straw, 925..	14.50	4.42	8.16	25.2	64.0
2	25	......	80	Wheat, 1,100.. Straw, 2,460..	37.60	15.10	24.58	Wheat, 305.. Straw, 905..	12.83	5.29	11.17	23.8	70.5
3	25	52	......	Wheat, 1,370.. Straw, 3,070..	44.01	19.39	25.94	Wheat, 575.. Straw, 1,415..	19.24	9.58	12.58	29.9	73.5
4	25	52	80	Wheat, 1,550.. Straw, 3,140..	45.81	19.59	29.61	Wheat, 755.. Straw, 1,585..	21.04	9.78	16.25	35.9	75.5
5	......	......	......	Wheat, 795.. Straw, 1,555..	24.77	9.81	13.36	....	....	....	....	....	....

It was shown in a previous table that the profit on plot 4 was $6.41, after deducting the cost of all plant-food used. A calculation, based on the results given in the above table, shows that of the plant-food applied there still remains to the credit of the farm 4 pounds of nitrogen, 42.2 of phosphoric acid and 63.8 of potash. Assuming that only the phosphoric acid and potash will be available for future crops, their value to the farm should be added to the profit already mentioned.

On the basis of yield per pound of nitrogen used, the best result is again shown on plot 4, where the nitrogen was applied in connection with both phosphoric acid and potash.

Most experimenters claim that at least one-third of the nitrogen applied in the form of nitrate would not be secured in the crop even under the most favorable conditions, since in any case certain amounts would be lost through drainage, the growth of weeds, etc.

The 160 pounds of nitrate of soda applied in this experiment contained 25 pounds of nitrogen. Assuming that the increased product was of the same composition as that on plot 5, the increase possible from two-thirds of the nitrogen, or 16⅔ pounds, would be 535 pounds of wheat and 1,047 of straw, whereas the actual yield was 755 pounds

of wheat and 1,585 of straw, which, while slightly lower in content of nitrogen, shows that either more than 16⅝ pounds was used, or that the plant was so increased in vigor as to enable it to secure the nitrogen in the soil from sources otherwise inaccessible.

Another point often urged against the use of nitrate is that it acts as a stimulant rather than a food, and not only increases straw in greater proportion than grain, but enables the plant to secure greater amounts of the mineral elements than would be the case on unmanured land. This is not proved by the analyses of the plant, for on plot 4, where the greatest yield was secured, the mineral elements in the products were not appreciably higher than in the produce from the unmanured land, and the proportion of straw to wheat was not materially changed. In the absence of a sufficient supply of the mineral elements, the nitrate caused a greater proportionate increase in the straw but no appreciable change in the proportionate amount of mineral elements removed. This shows that the proper use of nitrate would tend, under normal conditions, to increase the product proportionately in all directions, and that the exhaustion of the soil is in proportion to the increased crop. This result, showing the economical use of nitrogen upon wheat, is not only directly valuable to the farmer, but is an addition to results of a similar character which have been secured by experiment and practice, in this and in other countries.

DIRECTIONS TO BE OBSERVED IN THE USE OF NITRATE OF SODA ON WHEAT.

When the crop has not been fertilized in the fall, 100 pounds per acre would probably be more profitable than larger amounts.

If the soil contains an excess of potash and phosphoric acid which has been applied to previous crops or directly, the amount can be safely increased to 150 or 200 pounds per acre.

All lumps should be crushed and the application to the soil made as evenly as possible. In order to accomplish this it may be advisable to mix earth with the nitrate.

The best time to make the application is after the plants have obtained a fair start, in the spring. If possible, it should be applied before a light rain; this will insure complete distribution in the soil.

EXPERIMENTS OF COLLEGE FARM AND MR. HIGHT.

The experiments at the College farm and on the farm of Mr. Hight, while promising, early in the season, results quite as valuable as the above, were both ruined, that at the College farm by a blight or rust, about June 25th, which arrested the growth of the grain, and that on the farm of Mr. Hight by the wheat louse, or aphis.

The results are, however, published as a matter of record.

Number of Plot.	Fertilizer. Kind.	Weight per Acre.	Cost per Acre.	College Farm. Yield per Acre. Pounds of Wheat.	Bushels of Wheat.	Pounds of Straw.	H. H. Hight. Yield per Acre. Pounds of Wheat.	Bushels of Wheat.	Pounds of Straw.
1	Nitrate of Soda.........	160 lbs.	$3 71	1,100	18.3	3,400	750	12.5	1,690
2	Nitrate of Soda... ..... Muriate of Potash.....	160 " 160 "	7 31	1,235	20.6	3,165	820	13.7	1,580
3	Nitrate of Soda......... Superphosphate.........	160 " 320 "	7 81	1,300	21.7	3,500	1,020	17.0	1,940
4	Nitrate of Soda......... Muriate of Potash..... Superphosphate.........	160 " 160 " 320 "	11 41	1,140	19.0	3,110	1,030	17.2	2,890
5	Unfertilized.............	....	....	1,070	17.8	2,830	660	11.0	1,880

FIELD EXPERIMENTS WITH NITRATE OF SODA UPON TIMOTHY HAY.

This experiment was conducted on a field on the College farm. The field was seeded to timothy in the fall of 1886, and crops had been removed three years in succession previous to 1890.

The experiment plots were 33 by 600 feet, making an area of forty-five hundredths of an acre per plot. The nitrate, at the rate of 100 pounds per acre, was sown April 15th, at which time the hay had taken a good start, and appeared uniform in stand. The effect of the nitrate was noticed almost immediately in the darker color and rank growth of the grass. The crop was cut July 1st. On July 3d it was weighed, and put in the barn, at which time ten-pound samples were taken from each plot for analysis.

The yield was as follows:

	YIELD PER PLOT.	YIELD PER ACRE.
One hundred pounds Nitrate of Soda	4,015 pounds.	8,922 pounds.
Unfertilized	3,640 "	8,088 "

The samples for analysis were again weighed on October 31st, at which time No. 1 had lost 22.50 per cent. and No. 2, 20.40 per cent. of moisture. A complete drying showed a further loss of 5.60 per cent. for No. 1 and 6.54 per cent. for No. 2. The loss of moisture in the samples up to October 31st, was probably much greater than would have been the case if they had been placed in the mow. The analyses of 55 samples of timothy hay, made by Dr. Jenkins, of the Connecticut Station, show an average moisture of 10.21 per cent. On this basis the losses would have been 17.89 per cent. for No. 1 and 16.73 per cent. for No. 2. The actual yield of hay is shown when the yields at time of harvesting are reduced by the percentage loss of moisture, and would be as follows:

Yield from use of Nitrate	7,325 pounds.
Yield from Unfertilized Plot	6,735 "
Gain from use of Nitrate	590 "

The nitrate cost $2.25 per acre; timothy hay of the first quality is worth $12 per ton. The profit from the use of nitrate is therefore $1.29 per acre.

The analyses of the hay from these plots will be found in the table of analyses of fodders and feeds, on page 164.

FIELD EXPERIMENTS WITH FERTILIZERS ON SWEET POTATOES.

BY GEORGE E. FARRY, FARMINGDALE, MONMOUTH COUNTY.

It is the belief of many sweet potato growers in this State that the crop cannot be profitably increased by the use of commercial fertilizers alone. Hence, the usual practice is to use large quantities of barnyard manure, in many cases as high as twenty to thirty tons per acre. This practice involves not only considerable expense, but a great amount of labor.

The chief object of this experiment was to make a preliminary study of the crop in reference to the use of immediately available plant-food, with the expectation that the results secured might aid in

planning future experiments for the study of the best methods of manuring. The test was made as severe as possible by selecting a very light, sandy soil for the experiment. The results are tabulated mainly as a matter of record.

Number of Plot.	KIND OF FERTILIZER.	Quantity per Acre.	DATE OF APPLICATION OF NITRATE OF SODA. On May 20th.	On June 20th.	Cost of Fertilizer per Acre.	YIELD PER ACRE. Number of Bushels Good.	Number of Bushels Poor.	Total Number of Bushels.	Value per Acre of Crop.	Net Value of Crop.	Profit or Loss.
1	Unfertilized	....	....	....	....	40	15	55	$30 00	$30 00	....
2	Nitrate of Soda.....	160 lbs.....	160 lbs.....	....	$4 00	45	20	65	33 75	29 75	+$3 50
3	Nitrate of Soda.....	160 "	80 "	80 lbs.....	4 00	40	15	55	30 00	26 00	—0 25
4	Nitrate of Soda.....	320 "	320 "	....	8 00	35	15	50	26 25	18 25	—8 00
5	Nitrate of Soda.....	320 "	160 "	160 lbs.....	8 00	40	20	60	30 00	22 00	—4 25
6	Superphosphate.... Muriate of Potash.	320 " .. 160 " ..	....	....	7 20	57.5	20	77.5	43 13	35 93	+9 68
7	Nitrate of Soda..... Superphosphate.... Muriate of Potash.	160 " .. 320 " .. 160 " ..	160 lbs.....	....	11 20	90	30	120	67 50	56 30	+30 05
8	Nitrate of Soda..... Superphosphate.... Muriate of Potash.	160 " .. 320 " .. 160 " ..	80 "	80 lbs.....	11 20	85	25	110	63 75	52 55	+26 30
9	Nitrate of Soda..... Superphosphate.... Muriate of Potash.	320 " .. 320 " .. 160 " ..	320 "	....	15 20	65	30	95	48 75	33 55	+7 30
10	Nitrate of Soda..... Superphosphate.... Muriate of Potash.	320 " .. 320 " .. 160 " ..	160 "	160 lbs.....	15 20	90	35	125	67 50	52 30	+26 05
11	Barn-yard Manure.	20 tons.	....	....	30 00	120	20	140	90 00	60 00	+33 75
12	Unfertilized..........	....	....	....	....	30	15	45	22 50	22 50	....

The plots were 10 by 218 feet, one-twentieth of an acre in area, with four rows upon each plot. The barn-yard manure was applied in the hill, and, with the exception of the second application of nitrate of soda, on June 20th, the fertilizers were applied over about one-third of the space of the row at the time of setting the plants, on May 20th. The cultivation was lengthwise of the plots only. The potatoes were dug and weighed on October 15th.

RESULTS.

The yields on the blank plots, 1 and 12, and on plots 2, 3, 4 and 5, with nitrate of soda alone, were quite uniform, showing no effect from the use of this fertilizer. The yield of merchantable potatoes on plot 6 was increased over 60 per cent. by the use of phosphoric acid and potash. The best effects were secured on plots 7 and 10, where nitrogen was used in connection with mineral elements, with an increase of 32.5 bushels over plot 6, or 56 per cent. The best yield, 120 bushels per acre, was secured from barn-yard manure, on plot 11.

PROFIT AND LOSS.

In calculating values, the ruling price of 75 cents per bushel was used. Wherever nitrate was used alone, except on plot 2, there was a loss, ranging from 25 cents to $8. There was a profit from the use of mineral elements alone, and also in every case where the complete fertilizer was used, though not in any case as great as the profit from the barn-yard manure when the cost of the manure is rated at $1.50 per ton.

These results are instructive in showing that the profitable increase in yield may depend more upon the form of plant-food supplied, and its method of application, than upon the quantity used.

FIELD EXPERIMENTS WITH FERTILIZERS UPON PEACH TREES.

BY STEPHEN C. DAYTON, BASKING RIDGE, SOMERSET COUNTY.

Number of Plot.	FERTILIZERS.		VALUE OF CROP.			
	KIND.	Quantity per Acre.	1887.	1888.	1889.	Total Value.
1	Unfertilized...........	....	$53 30	$79 30	$5 45	$138 05
2	Nitrate of Soda......	150 lbs.	40 80	75 00	16 00	131 80
3	Superphosphate	350 "	81 25	112 45	35 25	228 95
4	Muriate of Potash...	150 "	61 75	115 05	58 90	235 70
5	Nitrate of Soda. .... Superphosphate	150 " 350 "	70 35	172 25	49 40	292 00
6	Unfertilized...	....	60 00	127 50	54 40	241 90
7	Nitrate of Soda. ... Muriate of Potash...	150 lbs. 150 "	56 90	147 50	83 35	287 75
8	Superphosphate ...... Muriate of Potash...	350 " 150 "	86 80	161 25	75 00	323 05
9	Nitrate of Soda....... Superphosphate ... Muriate of Potash...	150 " 350 " 150 "	76 10	209 30	76 25	361 65
10	Plaster.................	400 "	65 65	142 85	53 85	262 35
11	Barn-yard Manure...	20 2-horse loads.	73 80	235 95	81 25	391 00
12	Barn-yard Manure... Lime...........	10 loads. 50 bushels.	31 20	133 90	72 20	237 30

The above table shows the value of the crops for 1887, 1888 and 1889, calculated at an average price of 50 cents per basket. Below is appended Mr. Dayton's report on the experiment during the past year:

"I have to report a complete failure of the peach crop on the experiment orchard this year.

"The unusually warm weather during the winter caused the buds to become swollen and very forward. Many were killed during the winter, and those that were alive in the spring blossomed early and were destroyed by freezing weather while in bloom, so that there was not a basket of peaches on the entire orchard.

"The plots were plowed in the spring, the furrows being turned from the trees. The fertilizers were then carefully sown and harrowed in with a common drag-harrow, and the harrowing was repeated, to keep down the grass and weeds. The plowing and harrowing were always done the long way of the plots, and not across, to prevent dragging the fertilizers from one plot to another. The plots were plowed again early in August, and the furrows turned towards the trees, and the harrowing repeated.

"There was, as usual, a marked difference in the growth of grass and weeds on the different plots during the season. On plots fertilized with barn-yard manure and superphosphate they grew thick and strong; on the other plots they were thin and feeble.

"The greater part of the trees have become of large size compared with other peach trees in this vicinity. They are generally thrifty and promise well for next year.

"The trees in plots 1 and 2 have still shown less vigor than those in the other plots, and those in plot 7 have been as noticeable as last year for the dark-green color of their leaves.

"There have been few, if any, new cases of 'yellows' this season, and those trees that were attacked last year have shown very few of the abnormal yellow twigs, yet they seem feeble, and have made but little natural growth. The very sick tree on plot 12 is worse, and will be removed. The three trees attacked in 1887 are quite thrifty, and show no signs of disease, except being smaller than most of the trees in the plots in which they stand.

"I give below the average circumference in inches of the trunks of the trees in each plot, measured six inches above the ground, to show how the trees in each plot compare in size with those in the other plots:

Plot 1	16.0 inches.	Plot 7	17.4 inches.
" 2	15.5 "	" 8	17.3 "
" 3	17.2 "	" 9	18.2 "
" 4	16.3 "	" 10	16.7 "
" 5	18.1 "	" 11	19.3 "
" 6	16.6 "	" 12	18.5 "

"The plots are twenty feet wide and the trees were planted in the middle of the plots, which makes them about twenty feet apart. However, in plowing a deep furrow between the plots, it was found that the roots extend to the outside of the plots and probably beyond, which may account for the increasing difference in the yield between the unmanured plots 1 and 6.

"The broken and dead branches were removed from the trees before plowing, and they have needed very little other trimming."

FIELD EXPERIMENT WITH FERTILIZERS UPON PEACH TREES.

BY S. S. VOORHEES, MINE BROOK, SOMERSET COUNTY.

The object of this experiment is to test—

1. The effect upon the health and productiveness of peach trees of what may be considered a sufficient excess of the plant-food elements, nitrogen, phosphoric acid and potash, the first application to be made at the time of setting the trees, and thereafter as often as deemed necessary.

2. The comparative effects of different methods of fertilization.

The experiment contains three plots, one-fourth of an acre in area, each plot containing one row of 47 trees.

The soil is a gravelly, sandy loam, high and well drained, and in a good state of cultivation. The field was seeded to wheat in 1888, and mowed and lightly pastured in 1889.

The trees were set and corn planted on May 1st, and fertilizers applied broadcast on May 7th, just before a heavy rain. The corn was planted in hills, 3 feet 10 inches by 3 feet 10 inches. The trees look remarkably well all over the field, and equally good where no fertilizer was applied.

The yield and value of the corn crop is tabulated below as a matter of record, and for use in the future study of the experiment.

Number of Plot.	FERTILIZERS.			PER PLOT.		PER ACRE.		Total Value of Crop per Acre.
	KIND.	Quantity per Acre.	Cost per Acre.	Bushels of Shelled Corn.	Pounds of Stalks.	Bushels of Shelled Corn.	Pounds of Stalks.	
1	Ground Bone Muriate of Potash	600 lbs. 160 "	$18 70	12.8	602	51.2	2,408	$37 94
2	Nitrate of Soda Bone Black Muriate of Potash	160 " 240 " 160 "	9 44	11.6	560	46.4	2,240	34 56
3	Unfertilized	....	....	10.0	536	40.0	2,144	30 43

EXPERIMENTS WITH LUCERN, OR ALFALFA.

(*Medicago sativa.*)

This experiment was begun on the College farm in 1887, to study—

1. The adaptability of alfalfa as a forage crop to the soil and climate of New Jersey.
2. Methods of culture best suited to this crop.
3. Its economic value in farm practice.

In the annual reports of 1887, 1888 and 1889, detailed studies along these lines were recorded. A continuation of the work is reported this year.

The soil was prepared and seed sown on April 28th, 1887. An application of 15 tons of barn-yard manure per acre was made previous to sowing the seed.

PLAN OF EXPERIMENT.

A plot 30 feet wide and 150 feet long was carefully prepared. It had been in corn the preceding year, and as the subsoil is a compact clay, it was not believed to be specially fitted for alfalfa. Eighty pounds of a complete fertilizer, having an unusually high percentage of nitrogen and potash, were spread upon it broadcast. Approximately, one-half of the plot was then seeded in drills at the rate of 15 pounds of seed per acre; the rows were 14 inches apart. The other half of the plot was seeded broadcast, at the rate of 30 pounds of seed per acre.

APPLICATION OF FERTILIZERS.

In the latter part of April, 1888 and 1889, 50 pounds of a complete fertilizer, containing 2.80 per cent. total nitrogen, 11.00 per cent. total phosphoric acid, 8.00 per cent. available phosphoric acid and 4.22 per cent. potash, were broadcasted upon the two plots of alfalfa, which at that time showed a thick stand and a rapid and vigorous growth. Clover had not yet made a start.

Again in August, 1888, after the third cut was secured, the two plots received an application of thirty-five pounds of bone-black superphosphate and fifteen pounds of muriate of potash.

REPORT OF THE FOURTH YEAR'S GROWTH OF ALFALFA UPON THE COLLEGE FARM.

At the beginning of winter, 1889, the alfalfa showed a good stand, although bare spots could be seen in parts of the drilled plot, and plantain had taken possession of a small spot in the center of the broadcasted plot. It is believed that the delay in cutting the first crop in 1888 materially injured the subsequent crops.

In the spring of 1890 the growth was so vigorous as to completely cover the whole ground by the first week in May, when the drilled plot was cultivated.

It has been demonstrated that the best results are secured from alfalfa when it is cut just after the blossoms have appeared. In order to wait for this stage in its growth, therefore, the crop was left untouched until May 22d, when the first cutting was secured. Even at this date no blossoms were visible, although the buds were plainly developed. Both plots were quite free from weeds and no dodder was visible. *The yield was eight and one-tenth tons of green fodder per acre on the drilled plot, and ten and three-fourths tons per acre on the broadcasted plot.*

Blossoms began to appear about the middle of June, and on June 24th, when it was in full bloom, the second cutting was secured. *The yield was six and one-tenth tons of green fodder per acre on the drilled plot, and five and four-tenths tons per acre on the broadcasted plot.*

The third cutting was secured on July 30th. *The yield was three and six-tenths tons of green fodder per acre on the drilled plot, and three and eight-tenths tons per acre on the broadcasted plot.*

The fourth cutting was secured on September 16th, at which time the growth was much less vigorous than in the earlier part of the season. *The yield was four and nine-tenths tons of green fodder per acre on the drilled plot, and two and one-half tons per acre on the broadcasted plot.*

Following this cutting there was a rank growth, but it was deemed best to omit further cutting this season, pasturing lightly instead. *The total yield of green fodder per acre during the season of 1890 was, therefore, twenty-two and seven-tenths tons from the drilled plot, and twenty-two and forty-five hundredths tons from the broadcasted plot.*

The following table shows the yields of alfalfa from the drilled plot for 1887 to 1890, and from the broadcasted plot for 1888 to 1890. These have been calculated to the hay basis for the purpose of comparison.

Yield Per Acre of Alfalfa, 1887, 1888, 1889, 1890.

	Tons of Green Fodder.	Tons of Fodder on Hay Basis.
1887, Drilled Plot	20.79	4.44
1888, " "	18.70	5.54
1889, " "	22.50	6.67
1890, " "	22.70	6.72
1888, Broadcasted Plot	20.86	6.04
1889, " "	24.77	7.17
1890, " "	22.45	6.65

The table shows that 84.69 tons of the green alfalfa on the drilled plot would dry to 23.37 tons of hay, and that 68.08 tons on the broadcasted plot would dry to 19.86 tons. Since no cuts were made on the broadcasted plot in 1887, there still remains a balance to the credit of the drilled plot of 3.51 tons, a gain of 140 pounds for the drilled plot in 1890. This, exclusive of the cost of cultivating and hoeing, represents to this date the advantage of seeding in drills over broadcast seeding. The drilled plot was cultivated five times and hoed once during the first year's growth in 1887; in 1888 and 1889 it was cultivated three times; in 1890 but twice. An exact record of the cost of cultivation and hoeing has not been kept, but it is estimated to be not more expensive, with proper tools, than the cultivation of field corn.

The chief difficulty with this crop in most instances has been lack of success in securing a stand. It has, however, proven so successful on the small area under experiment at the College farm, that further experiments were begun this year in order to test the broadcast method of seeding alfalfa and its growth and adaptability to other soils of the State.

LOCATION OF EXPERIMENTS AND DESCRIPTION OF SOILS.

1. At the College farm the land had been in potatoes in 1889, and consisted of a rather heavy clay loam, with a compact reddish-clay subsoil.

2. Upon the farm of J. H. Denise, of Freehold, Monmouth county, the land had been in corn the previous year, and is a medium clay loam with clay subsoil. It had been heavily manured and is rich in mineral plant-food.

3. Upon the farm of G. B. Hurff, of Hurffville, Gloucester county, the soil is a sandy loam, with a porous, gravelly, clay subsoil. It was recently broken and is rich in organic and mineral matters.

4. Upon the farm of H. F. Bodine, of Locktown, Hunterdon county, this land was also new, a loose clay soil with open subsoil of same character.

The following directions in regard to the crop were furnished to each of the experimenters:

"The land should be plowed, then thoroughly harrowed and put in the best possible order. The fertilizers should be sown broadcast and harrowed in; the seed may be sown broadcast, and on stiff soils may be simply rolled in; a light harrow may be passed over light soils.

"A large amount of lime in the soil is of the first importance. Loamy sand, marls, also calcareous and clay marls, are especially suitable. The subsoil must be open, porous, not compact; surface soil of less importance.

"Farm-yard manure should not be used for at least one year before sowing, as it favors the growth of weeds and is often injurious to the growth of the plants. A heavy dressing of phosphoric acid, potash and lime should be applied and well harrowed in before seeding. From fifty to seventy-five pounds of nitrate of soda per acre is also advantageous.

"Use about twenty pounds of seed per acre, sowing it the last of April or the first of May. When sown broadcast a protective crop is advisable; oats at the rate of one peck per acre is perhaps the most suitable for spring seeding. Fall sowings are not certain in any case."

These directions were followed out in all cases as nearly as possible. The proper amounts of seed and fertilizer were furnished by the Station.

The experiment plot on the College farm consisted of one-half of an acre; the others, one-fourth of an acre each.

The fertilizers consisted of a mixture of a high-grade superphosphate, muriate of potash and nitrate of soda, the amounts of plant-food furnished being at the rate of 80 pounds of available phosphoric acid, 100 pounds of potash and 10 pounds of nitrogen per acre. The seed was sown broadcast the first week in May, and in all cases came up well.

The season was warm and moist and favorable for starting the plant. These conditions were also favorable for the growth of weeds. The first cut was made the third week in June, but in every case, except the College farm, the further growth of alfalfa was so light that the experiment was considered a failure.

The plot on the College farm was mowed again in August and September, and, at the beginning of winter, the stand was considered good, and promised quite as well as the plot sown in 1887, from which large crops have been cut for four seasons.

The economic value of this crop, especially for dairy farmers, has been the subject of much study by this Station, the results of which have been fully set forth in previous reports; and, though three of the experiments this year were unsuccessful, it is believed, from the success gained at the College farm, that with proper care in seeding, fertilizing and general management this valuable plant may yet be added to the forage crops of the State.

FODDERS AND FEEDS.

FODDERS AND FEEDS.

The chemical analysis of fodders and feeds consists in determining—

1. The amounts of the food compounds—crude fat, crude protein, crude fiber, carbo-hydrates and ash; and

2. The amounts of fertilizing elements—nitrogen, phosphoric acid and potash.

The terms fat, protein, fiber and carbo-hydrates have been fully described in all the former annual reports of this Station, which also contain full discussions in regard to digestibility, feeding standards, etc.

The chemical analysis and calculated digestibility of seventeen samples of fodders and feeds are reported this year on the following page.

DESCRIPTION OF SAMPLES.

563 and **564.** Timothy hay. From experiment at College farm with nitrate of soda. See page 149.

558–562. Wheat straw. From experiment of John Voorhees. See page 144.

501. Linseed meal. From Wilkinson, Gaddis & Co., Newark, N. J. Sent by B. C. Sears, New Brunswick.

502. Cotton-seed meal. From Wilkinson, Gaddis & Co., Newark, N. J. Sent by B. C. Sears, New Brunswick.

503. Dried brewers' grains. From the New York Feed Co. Sent by B. C. Sears, New Brunswick.

504. Dried brewers' grains. Sent by J. C. Griscom, Woodbury, N. J.

539. Dried brewers' grains. From Taylor Bros., Camden, N. J. Sent by H. D. Chew, Glassboro.

565. Malt sprouts. From factory of Peter Doelger, New York. Sent by V. R. Mathews, Ringoes, N. J.

FODDER AND FEED ANALYSES.

Station Number.	SAMPLE OF	POUNDS PER HUNDRED OF						IN 100 POUNDS OF FEED, NUMBER OF POUNDS DIGESTIBLE.				PERCENTAGE OF			Selling Price per Ton.	Station Number.
		Water.	Crude Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Carbo-hydrates.	Crude Fat.	Crude Fiber.	Crude Protein.	Carbo-hydrates.	Nitrogen.	Phosphoric Acid.	Potash.		
563	Timothy Hay	28.12	1.74	25.99	5.04	3.67	35.44	0.80	15.07	2.87	22.88	0.81	0.38	1.10	....	563
564	" "	26.94	1.76	26.72	6.09	3.78	34.76	0.81	15.50	3.47	21.90	0.97	0.37	1.04	....	564
558	Wheat Straw	6.41	1.11	39.53	3.50	4.08	45.87	0.30	20.56	0.91	18.15	0.56	0.13	0.69	....	558
559	" "	5.94	1.67	37.83	4.82	4.70	46.04	0.45	19.41	1.12	18.42	0.69	0.19	0.83	....	559
560	" "	6.84	1.64	38.05	3.52	4.53	45.92	0.44	19.79	0.92	18.87	0.56	0.19	0.72	....	560
561	" "	6.18	1.40	39.44	3.22	4.82	44.94	0.38	20.51	0.84	17.98	0.52	0.15	0.78	....	561
562	" "	6.72	1.48	37.74	3.29	4.70	46.07	0.40	19.62	0.86	18.43	0.53	0.14	0.67	....	562
501	Linseed Meal	9.64	5.78	7.08	32.38	6.23	38.89	5.26	1.84	28.15	35.89	5.18	2.32	1.32	$25 00	501
502	Cotton-Seed Meal	7.20	8.25	4.38	41.94	7.32	30.91	7.26	....	35.65	29.86	6.71	3.22	0.92	27 00	502
565	Malt Sprouts	9.89	1.29	10.20	25.78	6.33	46.56	1.08	....	20.58	46.56	4.12	1.54	2.13	18 40	565
503	Dried Brewers' Grains	8.25	6.37	12.24	23.56	2.99	46.59	5.10	....	20.08	46.59	3.77	0.91	0.18	15 00	503
504	" " "	9.55	4.96	12.72	22.00	6.58	44.19	3.97	....	18.70	44.19	3.52	1.01	0.19	20 00	504
539	" " "	9.55	6.05	13.58	24.21	3.41	43.20	4.84	....	20.58	43.20	3.87	0.70	0.08	17 00	539
568	" " "	9.40	8.57	13.89	26.38	3.47	38.79	6.86	....	22.42	38.79	4.22	1.16	0.07	17 00	568
569	" " "	7.38	7.53	10.84	28.25	3.68	47.32	6.02	....	19.76	47.32	3.72	1.19	0.15	20 00	569
570	Buffalo Feed	8.09	11.84	5.16	22.50	1.08	51.33	10.06	3.20	17.78	46.71	3.60	0.40	0.05	25 00	570
571	Chicago Feed	5.10	12.84	3.28	19.31	0.89	58.58	10.91	5.13	15.25	48.76	3.09	0.37	0.07	21 00	571

568. Dried brewers' grains. Sent by Evi A. Wilson, Deckertown, N. J.

569. Dried brewers' grains. Sent by Evi A. Wilson, Deckertown, N. J.

570. Buffalo feed. Sent by Evi A. Wilson, Deckertown, N. J.

571. Chicago feed. Sent by Evi A. Wilson, Deckertown, N. J.

The samples of timothy hay and wheat straw were secured from field experiment crops, and their analyses have been discussed on a previous page. The ten samples of feeds represent waste mill products, and are worthy of careful consideration by the farmer, since they furnish in a large degree the compounds, fat and protein, which are, as a rule, needed in order to economically use the usual fodders of the farm.

AVERAGE CHEMICAL ANALYSES OF FODDERS AND FEEDS.

Chemical analyses of a large number of samples of fodders and feeds have been made by this Station, including nearly all the materials serviceable as food for farm animals. The results of these analyses, showing the composition of the different samples and the variations in the composition of materials of the same kind, have appeared from year to year in the reports of this Station, accompanied by such comments and explanations as were deemed necessary.

The following tables of analyses have been arranged in such a manner as, it is believed, will facilitate their use by the farmer in the preparation of rations, examples of which are given in the reports of 1888 and 1889. These tables show the average pounds per hundred and per ton of the different digestible food compounds, and also the amount of ash and the fertilizing elements, and have been selected because they represent the principal feeding-stuffs, and also because the percentage of digestibility used can be reasonably relied upon.

TABLE OF ANALYSES

FOOD CONSTITUENTS (DIGESTIBLE).

Number of Analyses Averaged.	SAMPLE.		Dry Matter.	Crude Fat.	Crude Protein.	Carbo-hydrates, Including Fiber.	Nutritive Ratio.
11	Field Corn Stalks	lbs. per hundred	90.29	0.85	3.00	53.83	1:18.7
		lbs. per ton	....	17.00	60.00	1076.60	
20	Fodder Corn—Green	lbs. per hundred	....	0.30	1.22	14.83	1:12.8
		lbs. per ton	....	6.00	24.40	296.60	
1	Fodder Corn—Dry	lbs. per hundred	....	1.26	5.11	62.07	1:12.8
		lbs. per ton	....	25.20	102.20	1241.40	
11	Clover Hay	lbs. per hundred	92.30	1.68	8.35	44.28	1:5.8
		lbs. per ton	....	33.60	167.00	885.60	
12	Timothy Hay	lbs. per hundred	92.40	0.90	3.62	48.33	1:13.9
		lbs. per ton	....	18.00	72.40	966.60	
1	Lucern Hay	lbs. per hundred	92.30	1.46	13.33	38.48	1:3.2
		lbs. per ton	....	29.20	266.60	769.60	
3	Orchard Grass	lbs. per hundred	93.00	0.89	2.97	47.72	1:16.8
		lbs. per ton	....	17.80	59.40	954.40	
7	Pasture Grass	lbs. per hundred	36.88	1.03	4.29	20.36	1:5.4
		lbs. per ton	....	20.60	85.80	407.20	
6	Rye Straw	lbs. per hundred	93.36	0.40	0.78	49.92	1:65.3
		lbs. per ton	....	8.00	15.60	998.40	
7	Oat Straw	lbs. per hundred	91.94	0.64	1.53	40.93	1:27.8
		lbs. per ton	....	12.80	30.60	818.60	
10	Wheat Straw	lbs. per hundred	93.34	0.40	0.79	38.31	1:49.8
		lbs. per ton	....	8.00	15.80	766.20	
7	German Millet	lbs. per hundred	92.25	0.87	3.95	45.69	1:12.1
		lbs. per ton	....	17.40	79.00	913.80	
8	Oats—Ground	lbs. per hundred	88.88	3.90	9.83	49.31	1:6.0
		lbs. per ton	....	78.00	196.60	986.20	
7	Corn Meal	lbs. per hundred	87.21	3.30	6.58	65.49	1:11.2
		lbs. per ton	....	66.00	131.60	1309.80	
6	Brewers' Grains—Wet	lbs. per hundred	....	1.81	5.44	16.78	1:3.9
		lbs. per ton	....	36.20	108.80	335.60	
5	Brewers' Grains—Dried	lbs. per hundred	91.17	5.36	20.30	56.57	1:3.4
		lbs. per ton	....	107.20	406.00	1131.40	
2	Malt Sprouts	lbs. per hundred	89.82	1.08	16.22	53.70	1:3.5
		lbs. per ton	....	21.60	324.40	1074.00	
6	Cotton-Seed Meal	lbs. per hundred	91.03	10.18	37.47	21.92	1:1.3
		lbs. per ton	....	203.60	749.40	438.40	
7	Linseed Meal—Old Process	lbs. per hundred	90.51	5.95	27.86	36.80	1:1.8
		lbs. per ton	....	119.00	557.20	736.00	
2	Linseed Meal—New Process	lbs. per hundred	91.39	3.45	26.83	44.19	1:2.0
		lbs. per ton	....	69.00	536.60	883.80	
2	Gluten Meal	lbs. per hundred	91.28	4.77	24.15	49.04	1:2.5
		lbs. per ton	....	95.40	483.00	980.80	
6	Wheat Bran	lbs. per hundred	87.91	3.22	13.35	45.84	1:4.0
		lbs. per ton	....	64.40	267.00	916.80	
2	Wheat Chaff	lbs. per hundred	93.00	0.39	1.09	34.69	1:32.7
		lbs. per ton	....	7.80	21.80	693.80	
11	Wheat Middlings	lbs. per hundred	87.83	2.78	13.09	49.90	1:4.3
		lbs. per ton	....	55.60	261.80	998.00	

FODDERS AND FEEDS.

FERTILIZER CONSTITUENTS.

Number of Analyses Averaged.	SAMPLE.		Ash.	Nitrogen.	Phosphoric Acid.	Potash.
11	Field Corn Stalks	lbs. per hundred	5.98	0.94	0.26	1.02
		lbs. per ton	119.60	18.80	5.20	20.40
20	Fodder Corn—Green	lbs. per hundred	1.49	0.29	0.11	0.36
		lbs. per ton	29.80	5.80	2.20	7.20
1	Fodder Corn—Dry	lbs. per hundred	6.24	1.21	0.46	1.51
		lbs. per ton	124.80	24.20	9.20	30.20
11	Clover Hay	lbs. per hundred	6.80	1.99	0.36	1.68
		lbs. per ton	136.00	39.80	7.20	33.60
12	Timothy Hay	lbs. per hundred	4.37	1.02	0.37	1.31
		lbs. per ton	87.40	20.40	7.40	26.20
1	Lucern Hay	lbs. per hundred	8.07	2.63	0.41	2.45
		lbs. per ton	161.40	52.60	8.20	49.00
3	Orchard Grass	lbs. per hundred	5.17	0.91	0.28	1.64
		lbs. per ton	103.40	18.20	5.60	32.80
7	Pasture Grass	lbs. per hundred	3.27	0.91	0.23	0.75
		lbs. per ton	65.40	18.20	4.60	15.00
6	Rye Straw	lbs. per hundred	3.25	0.50	0.29	0.79
		lbs. per ton	65.00	10.00	5.80	15.80
7	Oat Straw	lbs. per hundred	4.75	0.65	0.22	1.22
		lbs. per ton	95.00	13.00	4.40	24.40
10	Wheat Straw	lbs. per hundred	3.73	0.53	0.11	0.74
		lbs. per ton	74.60	10.60	2.20	14.80
7	German Millet	lbs. per hundred	6.18	1.21	0.35	1.29
		lbs. per ton	123.60	24.20	7.00	25.80
8	Oats—Ground	lbs. per hundred	3.37	1.86	0.77	0.59
		lbs. per ton	67.40	37.20	15.40	11.80
7	Corn Meal	lbs. per hundred	1.41	1.45	0.62	0.39
		lbs. per ton	28.20	29.00	12.40	7.80
6	Brewers' Grains—Wet	lbs. per hundred	1.51	0.11	0.31	0.05
		lbs. per ton	30.20	2.20	6.20	1.00
5	Brewers' Grains—Dried	lbs. per hundred	4.03	3.82	0.98	0.12
		lbs. per ton	80.60	76.40	19.60	2.40
2	Malt Sprouts	lbs. per hundred	9.41	4.05	1.50	1,89
		lbs. per ton	188.20	81.00	30.00	37.80
6	Cotton-Seed Meal	lbs. per hundred	7.35	6.89	3.27	1.75
		lbs. per ton	147.00	137.80	65.40	35.00
7	Linseed Meal—Old Process	lbs. per hundred	5.83	5.41	2.11	1.45
		lbs. per ton	116.60	108.20	42.20	29.00
2	Linseed Meal—New Process	lbs. per hundred	6.04	5.71	2.22	1.59
		lbs. per ton	120.80	114.20	44.40	31.80
2	Gluten Meal	lbs. per hundred	0.94	4.89	0.12	0.05
		lbs. per ton	18.80	97.80	2.40	1.00
6	Wheat Bran	lbs. per hundred	6.05	2.45	2.92	1.59
		lbs. per ton	121.00	49.00	58.40	31.80
2	Wheat Chaff	lbs. per hundred	7.18	0.68	0.95	0.56
		lbs. per ton	143.60	13.60	19.00	11.20
11	Wheat Middlings	lbs. per hundred	2.43	2.38	1.21	0.65
		lbs. per ton	48.60	47.60	24.20	13.00

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS.

EXPERIMENTS WITH DIFFERENT BREEDS OF DAIRY COWS.

At a meeting of the Board of Managers of the New Jersey Agricultural Experiment Station, September 15th, 1888, a committee was appointed to arrange for a series of trials of different breeds of dairy cows. The object being to determine, by carefully planned and executed experiments, the cost and value of the products from each of the different breeds, and the following notice was largely distributed:

"The breeds to be tested are Ayrshires, Guernseys, Holstein-Friesians, Jerseys and Short-Horns. Three animals of each breed will be selected. The several animals must be fair representatives of their breed. To secure this end, the several cattle clubs of the country were requested to co-operate with this committee in selecting their representative animals, to describe them, and to authorize their use for this object. The cows must be in such condition as to be proper subjects for experiment, record and publication. For animals approved by the several clubs, the Station agrees to pay $100 per head when safely delivered at the Agricultural College Farm; to furnish proper shelter, food and care; to make full and accurate records and reports of all experiments made; and to give ready and free access to the representatives of the several cattle clubs which take part in the experiment.

"The experiments in feeding, milking, weighing, measuring, etc., will be carried out on the farm of the Agricultural College, and the analyses of the food and milk will be made at the laboratory of the Agricultural Experiment Station, and they will probably extend over a period of from two to four years."

The committee entered into correspondence with the clubs most largely represented in the State, and the plan was approved and entered on by the following clubs, viz.:

The Ayrshire, Ayrshire Breeders' Association,
C. M. Winslow, Secretary, Brandon, Vt.

Guernsey, American Guernsey Cattle Club,
Edward Norton, Secretary, Farmington, Conn.

Holstein-Friesian, Holstein-Friesian Association of America,
Thos. B. Wales, Secretary, Iowa City, Iowa.

Jersey, Philadelphia Jersey Breeders' Club,
John P. Hutchinson, Secretary, Bordentown, N. J.

Short-Horn, American Short-Horn Breeders' Association,
J. H. Pickrell, Secretary, Chicago, Ill.

Representative animals were selected by the committee from each of the clubs, and the work begun by the Station on May 1st, 1889. Plans were adopted with the aim of making the farm records accurate and complete, and the chemical study of the products of such a character as to ensure the widest practical use of the final conclusions. It was clearly recognized from the beginning that the management of the animals was of the greatest importance. The feeding and care were therefore so conducted as to give full credit to the special characteristics of the different breeds. The lines of study begun and only partially accomplished November 1st, 1890, were:

1. To keep an exact daily record of the food consumed and the milk produced.
2. To determine the average composition of the milk by studying the variations likely to occur in the quality of the milk of the individual animals and herds of the different breeds under the conditions of season that exist throughout the year, and during the different periods of lactation of the animals.
3. To study the food value of the milk, and the adaptability of that of the different breeds to the various purposes of the dairy.
4. To study the comparative cost of the actual food compounds in the milk produced and the most economical utilization of those from the different breeds.
5. To study the relative value of the breeds represented, in reference to the economical use of coarse farm products.

It will be observed from the above that the Station had not contemplated an end of the experiments for a considerable period, and that the records so far secured, while presenting many points of interest and of value, are too limited to warrant detailed conclusions in regard to the main question, to which all the lines of work were directed, viz., "a comparison of the different dairy breeds."

This experiment was suddenly interrupted by the burning of the entire herd in the barns of the Agricultural College on the evening of November 2d, 1890.

FOOD.

It was believed by practical dairymen that the food provided for the herds during the summer and fall of 1889 conformed closely in kind and quantity to that used in regular milk dairies. As stated in

Bulletin 61 of last year, it was thought that the variations in and the poor quality of the green food supplied, due to the extreme moisture of the season, contributed largely to the variations observed in the quality of the milk.

The following analysis of the green fodder corn shows the variations which may have occurred in the rations supplied during August and September of 1889:

	Dry Matter.	DIGESTIBLE Fat.	Protein.	Carbo-hydrates, including Fiber.
August 1st	16.57	0.24	0.78	9.96
August 7th	22.81	0.38	1.26	13.29
September 2d	27.25	0.73	1.33	15.51

This table indicates that the corn fodder contained the minimum of solid matter on August 1st, and that on September 1st, 50 pounds of the corn fodder would have furnished almost the same quantity of food compounds as were contained in 100 pounds on the 1st of August.

A study of these analyses, in connection with a comparison of the other materials fed, indicated that there were wide variations in both the amount and proportion of food compounds supplied from month to month.

Early in December various forms of concentrated feeds were bought, a chemical analysis made in each, and a ration prepared which approximated closely in kind and quantity of food compounds to the *standard daily ration* for milk cows of 1,000 pounds live weight, viz., 0.40 pounds fat, 2.50 proteine and 12.50 carbo-hydrates. The ration for the cows of different weights varied in the total amount of food supplied by it, and not in the proportion of the food compounds to each other.

This ration was substituted on December 15th, and continued in use till February 1st, the Superintendent making such deviations from the actual amounts indicated as in his judgment the varying condition of the individual cows might demand.

Tabular statements showing the food furnished by the average rations fed, the average yield of milk per cow per day, and its average quality, are published on subsequent pages. From August 9th to November 1st the cows were allowed, during pleasant weather, to pasture for three hours daily. Since the amount of food thus secured must have been a variable quantity, it is not included in the ration. Our analyses of pasture grasses show that the food compounds con-

tained in them are essentially in the same proportion as is shown in the standard ration. Consequently, however much or little may have been eaten, the nutritive ratios shown in the table would not be changed.

On December 1st a form was prepared for the Farm Superintendent, to be filled out each day and filed in the Station's laboratory. The copy of the filled-out form for December 20th, to be found on the next page, may be of interest to dairymen, and also serve as an aid to them in securing uniform and accurate records.

By means of this daily record the Chemist is also furnished with a full knowledge of the condition of the herd, and thus may note immediately any conditions which might affect the quality of the milk.

CHEMICAL ANALYSIS.

The samples were taken by the Farm Superintendent, and each sample was accompanied by a statement similar to the following:

> Sample of *Milk*.
> Sample No............Received....................................18.........
> From *College Farm*.
> Herd of *three cows*.
> Breed, *Ayrshire*. Name ....
> Representing *Total yield for one day*.
> Sampled, sealed and delivered by *B. C. Sears, Superintendent*.
> Date...

Samples were taken and analyses made three days in each week except during the month of October, 1889, and the first two weeks in September; the milk from cows in ill health or not in their normal condition from any cause, was not included in the sample. It is believed that the condition of the animals was such that the composition of the milk of the different breeds, as shown in the tables, fairly represents the variations likely to occur through different seasons and periods of lactation, and that the final averages of complete analyses, though representing the study of but eight months, do show what may be safely depended upon as the actual average composition of the milk from the breeds represented.

DAILY RATIONS AND YIELD OF MILK OF EXPERIMENTAL HERD AT COLLEGE FARM.

BREED.	AYRSHIRE.						GUERNSEY.						HOLSTEIN-FRIESIAN.						JERSEY.						SHORT-HORN.					
NAME.	Miss Cornelia 2d.		Hattie Pearl.		Young Duchess.		Cherry du Laurier.		Ada.		Dolly Ford.		Jewel 3d.		Evadne.		Benola Fletcher.		Annie Dale's Princess.		Doecheco.		Hero's Blossom.		Yarico Lass.		Helen Mansfield.		Nettie Mansfield 3d.	
Yield—	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Morning	10	12	16	14	15	14	5	2	13	......	9	......	5	12	14	2	25	10	10	10	9	12	9	14	10	2	11	6	2	2
Evening	7	2	10	4	9	10	3	14	8	8	7	14	4	10	10	2	21	6	7	4	6	14	7	......	7	......	7	10	1	8
Total	17	14	27	2	25	8	9	......	21	8	16	14	10	6	24	4	47	......	17	14	16	10	16	14	17	2	19	......	3	10

Rations—	Miss Cornelia 2d.	Hattie Pearl.	Young Duchess.	Cherry du Laurier.	Ada.	Dolly Ford.	Jewel 3d.	Evadne.	Benola Fletcher.	Annie Dale's Princess.	Doecheco.	Hero's Blossom.	Yarico Lass.	Helen Mansfield.	Nettie Mansfield 3d.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lb .	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Hay	10	10	10	10	10	10	15	15	15	10	10	10	10	10	10
Corn Meal	6	6	6	8	6	6	4	6	6	6	6	6	6	6	6
Wheat Bran	6	6	6	8	6	6	8	10	10	6	6	6	6	6	6
Cut Stalks	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cotton-Seed Meal	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Linseed Meal	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Dried Brewers' Grains	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Turnips	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Not Eaten	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Weight of Cow	1,010	875	825	995	900	945	1,385	1,815	1,206	950	890	880	1,200	1,205	1,270

Time of Feeding: 7 A. M., 2:30 P. M., and at 5:30 P. M.; turnips and hay.
Time of Milking: Morning, 5:15 to 7. Evening, 3:15 to 5:30.

Time of Watering: 8 A. M., 10 A. M., 2:30 P. M.
Remarks: Dolly Ford was served by Beau of Norwood, No. 1,102.

NEW BRUNSWICK, N. J., December 20th, 1889.

B. C. SEARS, *Superintendent.*

LIST OF COWS.

REGISTERED NAME.	Registered Number.	Received from the Herd of	Dropped.	Last Calf.	Description of Cow.
Ayrshire—					
Miss Cornelia 2d	8,404	L. S. Drew, Burlington, Vt	Mar. 18, '84	Mar. 27, '89	Dark Red and a little White.
Miss Cornelia 3d	8,934	L. S. Drew, Burlington, Vt	Mar. 29, '85	Feb. 19, '90	Dark Red and a little White.
Hattie Pearl	8,241	Isaac Hazard, Providence, R. I.	Mar. 22, '84	Aug. 3, '90	Dark Red and White.
Young Duchess	9,285	Henry E. Smith, Providence, R. I	Aug. 20, '85	Oct. 16, '90	Red and White.
Guernsey—					
Dairymaid 3d	3,089	E. N. Howe [illegible] N. Y	July 15, '84	Mar. —, '89	Solid Lemon Fawn.
Cherry du Laurier 4th	2,240	E. Norton, [illegible]	Mar. 24, '82	Apr. 15, '90	Red Fawn and White.
Ada	1,439	James L. F[illegible]a, Pa	Jan. 16, '83	Sept. 25, '90	Lemon Fawn with White.
Dolly Ford	1,595	S. L. Hoxie [illegible] N. Y	Apr. 30, '82	May 10, '89	Light Fawn and White.
Holstein-Friesian—					
Jewel 3d	2,188	Dallas B. Whipple, Cuba, N. Y	Mar. 11, '82	Apr. 12, '89	Black with White Spots.
Evadne	5,005	J. R. McPherson, Belle Mead, N. J.	Mar. 25, '82	June 4, '90	Black with White Spots.
Benola Fletcher	6,891	Smiths, Powell & Lamb, Syracuse, N. Y.	Mar. 10, '83	Oct. 17, '90	Three-fourths Black, Star.
Jersey—					
Annie Dale's Princess.	12,664	J. E. Parmly, Oceanic, N. J.	July 17, '79	Apr. 11, '90	Light Fawn and White.
Doecheco	14,574	Chas. S. Taylor, Burlington, N. J.	Feb. 9, '82	July 7, '90	Dark Fawn.
Hero's Blossom.	29,245	A. H. Moore, Colmar, Montgomery Co., Pa	May 20, '83	Aug. —, '89	Fawn and White.
Short-Horn—	A. H. B.				
Yarico Lass 8th of Mansfield	Vol. 23	Augustus Storrs, Storrs, Conn	Nov. 20, '81	July 19, '90	Red with Star and little White.
Helen Mansfield	Vol. 21	R. H. Allen, Chatham, N. J	Sept. 12, '82	Apr. 26, '89	Red.
Nettie Mansfield 3d.	Vol. 20	Augustus Storrs, Storrs, Conn.	Oct. 1, '80	Apr. 4, '90	Roan.

RECORD FOR MAY, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED. Pounds.	MILK PRODUCED. Ounces.	WEIGHT OF COW. Eighth.	WEIGHT OF COW. Fifteenth.	WEIGHT OF COW. Twenty-first.	WEIGHT OF COW. Thirtieth.	FOOD CONSUMED Wheat Bran.	FOOD CONSUMED Corn Meal.	FOOD CONSUMED Green Fodder Rye.	FOOD CONSUMED Hay.	Remarks.
Ayrshire—								lbs.	lbs	lbs.	lbs.	
Miss Cornelia 2d	8,404	747	2	......	900	925	935	124	93	600	10	Arrived at farm on 16th.
Hattie Pearl	8,241	339	2	......	......	......	800	9	{33 C. Cob Meal...}	230	20	" " " " 22d.
Young Duchess	9,285	140	......	......	......	......	770	9	{33 C. Cob Meal...}	230	20	" " " " 22d.
Guernsey—												
Dairymaid 3d	3,089	1,055	8	937½	930	940	950	199	152½	660	120	
Ada	1,439	194	12	937½	950	965	845	67	64	660	120	Was not dried but milked up to time of calving, May 29th.
Dolly Ford	1,595	89	......	......	......	......	775	12	8	100	......	Dolly Ford arrived at farm on 29th.
Holstein-Friesian—												
Jewel 3d	2,188	......	......	......	......	......	......	......	......	......	......	
Evadne	5,005	......	......	......	......	......	......	......	......	......	......	
......	......	......	......	......	......	......	......	......	......	......	......	
Jersey—												
Annie Dale's Princess	12,664	918	8	840	840	840	830	197½	127½	660	120	
Doecheco	14,574	964	12	830	840	825	832½	199½	153	600	120	
Hero's Blossom	29,245	......	......	......	......	......	......	......	......	......	......	
Short-Horn—	A. H. B.											
Yarico Lass 8th of Mansfield	Vol. 23	1,121	......	1,070	1,062	1,075	1,070	245½	245½	660	120	
Helen Mansfield	Vol. 21	1,034	10	1,050	1,075	1,040	1,050	222	210	660	120	
Nettie Mansfield 3d	Vol. 20	953	2	1,047½	1,067½	1,050	1,045	242½	242½	660	120	

RECORD FOR JUNE, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED.		WEIGHT OF COW.				FOOD CONSUMED.			Remarks.
		Pounds.	Ounces.	Sixth.	Thirteenth.	Nineteenth.	Twenty-sixth.	Wheat Bran.	Corn Meal and Corn Cob Meal.	Green Feed, Red and Alsike and Orchard Grass.	
Ayrshire—								lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	927	4	950	997½	1,002½	1,045	180	114	1,300	Miss Cornelia 2d suffered from severe attack of foot-ail during last of month.
Hattie Pearl	8,241	1,170	10	800	830	822½	900	None.	171	1,300	Hattie Pearl and Young Duchess would eat no more feed than indicated.
Young Duchess	9,285	513	2	770	815	835	882½	None.	118	1,150	
Guernsey—											
Dairymaid 3d	3,089	874	6	935	957½	935	1,000	180	114	1,295	
Ada	1,439	820	......	870	822½	850	880	180	112½	1,150	
Dolly Ford	1,595	924	4	825	873	880	1,000	135	90	1,150	
Holstein-Friesian—											
Jewel 3d	2,188	......	......	......	......	......	......	......	......	......	
Evadne	5,005	......	......	......	......	......	......	......	......	......	
......	......	......	......	......	......	......	......	......	......		
Jersey—											
Annie Dale's Princess	12,664	875	4	860	905	855	905	180	114	1,200	
Doecheco	14,574	890	6	850	887½	882½	950	180	114	1,200	
Hero's Blossom	29,245	......	......	......	......	......	......	......	......	......	
Short-Horn—	A. H. B.										
Yarico Lass 8th of Mansfield	Vol. 23.	1,013	14	1,050	1,097½	1,110	1,160	19½	287½	1,295	
Helen Mansfield 3d	Vol. 21.	1,075	8	1,075	1,137¾	1,115	1,160	128	178	1 295	
Nettie Mansfield 3d	Vol. 20.	867	6	1,075	1,127½	1,095	1,160	130	180	1,295	

RECORD FOR JULY, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED. Pounds.	MILK PRODUCED. Ounces.	WEIGHT OF COW. Fourth.	WEIGHT OF COW. Eleventh.	WEIGHT OF COW. Seventeenth.	WEIGHT OF COW. Twenty-fourth.	FOOD CONSUMED. Oat and Corn Meal.	FOOD CONSUMED. Wheat Bran.	FOOD CONSUMED. Clover and Grass and Fodder Corn.	Remarks.
Ayrshire—								lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	780	12	1,025	1,020	1,010	1,035	93	186	1,395	Suffered with sore feet part of month.
Hattie Pearl	8,241	915	10	890	825	820	850	173	None.	1,395	Suffered with sore feet part of month; would not eat bran.
Young Duchess	9,285	338	12	875	865	850	850	67	None.	1,240	Would not eat bran.
Guernsey—											
Dairymaid 3d	3,089	727	....	1,000	990	950	950	93	186	1,395	
Ada	1,439	836	10	865	825	830	875	93	186	1,240	
Dolly Ford	1,595	782	2	975	960	930	960	93	139½	1,240	Had a little pasture.
Holstein-Friesian—											
Jewel 3d	2,188	341	4	....	....	....	1,185	46	50	520	Arrived on night of 20th.
Evadne	5,005	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	
Jersey—											
Annie Dale's Princess	12,664	677	6	900	870	860	850	93	186	1,240	
Doecheco	14,574	729	8	915	877½	880	870	93	186	1,395	
Hero's Blossom	29,245	....	....	....	....	....	....	....	....	....	
Short-Horn—	A. H. B.										
Yarico Lass 8th of Mansfield	Vol. 23	879	6	1,125	1,100	1,110	1,115	243½	None.	1,395	Would not eat bran.
Helen Mansfield	Vol. 21	879	8	1,140	1,115	1,085	1,105	139½	124	1,395	
Nettie Mansfield 3d.	Vol. 20	708	......	1,145	1,150	1,135	1,135	139½	124	1,395	

RECORD FOR AUGUST, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED — Pounds.	MILK PRODUCED — Ounces.	WEIGHT OF COW. — Eighth.	WEIGHT OF COW. — Fifteenth.	WEIGHT OF COW. — Twenty-second.	WEIGHT OF COW. — Thirtieth.	FOOD CONSUMED. — Corn Cob, Corn and Oat Meal.	FOOD CONSUMED. — Wheat Bran.	FOOD CONSUMED. — Green Corn Fodder.	FOOD CONSUMED. — Pasture.	FOOD CONSUMED. — Hay.	FOOD CONSUMED. — Gluten Meal.	FOOD CONSUMED. — Oil Meal.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	
Miss Cornelia 2d..	8,404	811	6	975	970	980	975	93	186	1,575	After 9th 3 hours daily...	18	.....	....	
Hattie Pearl..	8,241	943	6	795	770	805	805	124½	16	1,575	"	18	30	10	
Young Duchess	9,285	248	14	850	815	840	825	153½	....	1,575	"	.....	.....	.....	The pasture consisted of second crop of clover, fully headed out.
Guernsey—															
Dairymaid 3d...	3,089	706	12	950	900	950	920	93	186	1,700	"	18	.....	.....	
Ada.	1,439	800	14	850	825	840	850	93	186	1,575	"	21	.....	.....	
Dolly Ford	1,595	696	6	952½	910	945	925	93	137½	1,575	"	18	.....	.....	The corn fodder during the early part of the month was rather young. Later, had a considerable number of ears.
Holstein-Friesian—															
Jewel 3d	2,188	1,056	2	1,125	1,145	1,165	1,200	154	186	1,700	"	18	.....	....	
Benola Fletcher	....	....	.....	......	....	......	......	......	......	......	....	.....	.....	.....	
Jersey—															
Annie Dale's Princess	12,664	733	.....	815	815	810	832	93	186	1,575	"	....	....	.....	All were fed the corn and cob-meal up to the 22d inst., and then equal parts of corn and oats (ground together) were used.
Doecheco...	14,574	725	8	840	835	875	850	93	186	1,575	"	.....	.....	.....	
Short-Horn—	A. H. B.														
Yarico Lass 8th of Mansfield	Vol. 28	810	12	1,075	1,025	1,010	1,050	248	..	1,700	"	...	.....	....	
Helen Mansfield...	Vol. 21	859	6	1,050	1,025	1,100	1,065	139½	124	1,700	....	.....	.....	.....	
Nettie Mansfield 3d.	Vol. 20	655	4	1,105	1,095	1,095	1,100	139½	124	1,700	....	.....	.....	.....	

RECORD FOR SEPTEMBER, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED: Pounds.	MILK PRODUCED: Ounces.	WEIGHT OF COW: Fifth.	WEIGHT OF COW: Thirteenth.	WEIGHT OF COW: Twentieth.	WEIGHT OF COW: Twenty-seventh.	FOOD CONSUMED: Corn Cob, Corn and Oat Meal.	FOOD CONSUMED: Wheat Bran.	FOOD CONSUMED: Green Corn Fodder.	FOOD CONSUMED: Pasture.	FOOD CONSUMED: Cut Clover (Green).	FOOD CONSUMED: Hay.	FOOD CONSUMED: Oil Meal.	FOOD CONSUMED: Gluten Meal.	Remarks.
Ayrshire—				A. M.	P. M.	P. M.	P. M.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d..	8,404	819	8	965	1,080	1,050	1,077½	107	186	570	3 hours daily.	330	33	.....	.....	All weights after the 5th inst. were taken in the afternoon, after pasturing and watering.
Hattie Pearl..	8,241	1,016	12	815	850	870	892½	120	94	570	"	330	33	60	22	
Young Duchess	9,285	107	6	830	910	910	905	.....	.....	.....	.....	.....	.....	.....	.....	Milk-flow ceased on 16th inst.
Guernsey—																
Dairymaid.	3 089	701	10	940	1,020	910	905	107	186	570	"	330	33	.....	.....	
Ada	1,439	709	8	850	860	870	897½	107	186	570	"	330	33	.....	.....	
Dolly Ford	1,595	622	4	910	925	1,250	1,275	101	158	570	"	330	33	.....	.....	Injured in hip on the 13th inst.; rendered her lame, but milk-flow not affected.
Holstein-Friesian—																
Jewel 3d	2,188	1,001	6	1,180	1,230	1,250	1,325	180	186	570	"	330	33	.....	.....	
Evadne	5,005	913	10	1,250	1,275	1,250	1,267½	38	168	570	"	330	33	.....	.....	Delivered at the farm September 3d.
Benola Fletcher	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Jersey—																
Annie Dale's Princess	12,664	717	2	840	920	900	917½	90	186	570	"	330	33	.....	.....	
Doecheco	14,574	676	9	860	920	945	950	90	186	570	"	330	33	.....	.....	
Hero's Blossom	29,245	571	4	800	880	825	912½	81	149	480	"	330	33	.....	.....	Delivered at the farm September 3d.
Short-Horn—	A. H. B.															
Yarico Lass 8th of Mansfield	Vol. 23	812	3	1,075	1,140	1,190	1,180	140	140	570	"	330	33	.....	.....	
Helen Mansfield...	Vol. 21	853	12	1,080	1,180	1,175	1,195	126½	156	570	"	330	33	.....	.....	
Nettie Mansfield 3d.	Vol. 20	650	14	1,110	1,185	1,150	1,119½	126½	156	570	"	330	33	.....	.....	

RECORD FOR OCTOBER, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED. Pounds.	MILK PRODUCED. Ounces.	WEIGHT OF COW. Fourth.	WEIGHT OF COW. Eleventh.	WEIGHT OF COW. Nineteenth.	WEIGHT OF COW. Twenty-sixth.	FOOD CONSUMED. Corn and Oat Meal.	FOOD CONSUMED. Gluten Meal.	FOOD CONSUMED. Wheat Bran.	FOOD CONSUMED. Timothy to 20th; then half Timothy and half Clover Hay.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	778	14	1,080	1,125	1,160	1,190	124	.....	186	300	
Hattie Pearl	8,241	955	12	905	940	930	980	124	62	124	300	
Young Duchess	9,285	After 25th, 278	6	815	900	915	965	84	.....	99	300	Dropped heifer calf Oct. 4th. Calf taken off Oct. 28th, noon.
Guernsey—												
Dairymaid 3d	3,089	To 17th, 372	8	1,010	1,025	965	910	62	.....	96	300	Was taken on 17th with gar- get ve been t veteri that d use.
Ada	1,439	746	12	905	925	965	970	122	.....	186	300	
Dolly Ford	1,595	617	8	960	1,000	980	1,045	124	.....	186	300	
Holstein-Friesian—												
Jewel 3d	2,188	662	6	1,330	1,340	1,370	1,410	To 19th, 114; After 19th, 18	.....	205	300	Affected slightly with sores on udder. Feed reduced on 19th.
Evadne	5,005	973	12	1,325	1,340	1,365	1,375	186	.....	232	300	
Benola Fletcher	....	....	....	....	....	....	....	....	.....	.....	....	Delivered at the farm October 25th.
Jersey—												
Annie Dale's Princess	12,664	688	2	955	925	940	1,005	110	.....	186	280	
Doecheco	14,574	617	6	965	985	990	1,050	110	.....	186	280	
Hero's Blossom	29,245	625	14	935	945	940	985	110	.....	186	280	
Short-Horn—	A. H. B.											
Yarico Lass 8th of Mansfield	Vol. 23	767	10	1,200	1,240	1,235	1,275	124	.....	186	300	
Helen Mansfield	Vol. 21	784	14	1,200	1,240	1,260	1,385	124	.....	186	300	
Nettie Mansfield 3d	Vol. 20	618	4	1,215	1,240	1,245	1,275	124	.....	128	300	

RECORD FOR NOVEMBER, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED.		WEIGHT OF COW.					FOOD CONSUMED.			Remarks.
		Pounds.	Ounces.	Second.	Eighth.	Fifteenth.	Twenty-second.	Twenty-ninth.	Timothy Hay.	Corn and Oat Meal.	Wheat Bran.	
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	571	14	1,120	1,160	1,140	1,180	1,100	600	52	188	
Hattie Pearl	8,241	791	12	945	935	975	980	920	600	180	120	
Young Duchess	9,285	696	6	875	895	940	885	860	600	52	126	
Guernsey—												
Dairymaid 3d.	3,089	317	12	910	910	945	975	940	....	....	....	Sick, and fed very little but bran most of the month. Her record not included in the average.
Ada	1,439	598	8	910	910	935	965	890	600	120	180	
Dolly Ford	1,595	502	8	1,025	985	1,065	985	950	600	120	180	
Holstein-Friesian—												
Jewel 3d	2,188	379	.....	1,350	1,335	1,375	1,325	1,425	750	180	240	
Evadne	5,005	818	8	1,325	1,325	1,350	1,365	1,365	750	180	300	
Benola Fletcher	6,891	1,472	10	1,235	1,230	1,260	1,295	1,290	750	180	300	
Jersey—												
Annie Dale's Princess	12,664	511	10	950	950	965	1,015	945	600	120	180	
Doecheco	14,574	501	10	965	980	1,010	1,000	910	600	120	180	
Hero's Blossom	29,245	499	6	920	930	970	990	895	600	120	180	
Short-Horn—	A. H. B.											
Yarico Lass 8th of Mansfield	Vol. 23	563	10	1,205	1,235	1,200	1,270	1,270	600	120	180	
Helen Mansfield.	Vol. 21	631	14	1,195	1,225	1,260	1,280	1,195	600	120	180	
Nettie Mansfield.	Vol 20	347	14	1,200	1,225	1,285	1,315	1,225	600	120	120	

RECORD FOR DECEMBER, 1889.

REGISTERED NAME.	Registered Number.	MILK PRODUCED. Pounds.	MILK PRODUCED. Ounces.	WEIGHT OF COW. Fifth.	WEIGHT OF COW. Thirteenth.	WEIGHT OF COW. Twentieth.	WEIGHT OF COW. Twenty-seventh.	FOOD CONSUMED. Timothy Hay.	FOOD CONSUMED. Corn and Oat Meal.	FOOD CONSUMED. Wheat Bran.	FOOD CONSUMED. Turnips.	FOOD CONSUMED. Cotton-Seed Meal.	FOOD CONSUMED. Corn Stalks.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	541	8	1,100	1,095	1,010	1,075	450	130	186	254	34	85	
Hattie Pearl	8,241	883	2	930	900	875	900	450	186	186	254	34	85	
Young Duchess	9,285	817	6	860	840	825	885	450	158	186	254	34	85	
Guernsey—														
Cherry du Laurier 4th	2,240	129	6	....	....	995	1,005	140	45	45	112	13	70	Arrived at College farm December 17th. Dairymaid taken away on account of sore udder.
Ada	1,439	614	6	915	890	900	925	450	158	186	254	34	85	
Dolly Ford	1,595	513	12	1,025	1,005	945	990	450	158	186	254	34	85	
Holstein-Friesian—														
Jewel 3d	2,188	262	13	1,370	1,375	1,385	1,405	595	152	248	254	34	85	
Evadne	5,005	762	14	1,325	1,290	1,315	1,325	595	186	310	254	34	85	
Benola Fletcher	6,891	1,500	6	1,230	1,200	1,205	1,240	595	186	310	254	34	85	
Jersey—														
Annie Dale's Princess	12,664	528	8	950	955	950	985	450	158	186	254	34	85	
Doecheco	14,574	502	8	930	905	890	890	450	158	186	254	34	85	
Hero's Blossom	29,245	521	......	905	885	880	885	450	158	186	254	34	85	
Short-Horn—	A. H. B.													
Yarico Lass 8th of Mansfield	Vol. 23	534	2	1,210	1,150	1,200	1,170	450	158	186	254	34	85	
Helen Mansfield	Vol. 21	570	12	1,225	1,165	1,205	1,235	450	158	186	254	34	85	
Nettie Mansfield	Vol. 20	113	8	1,260	1,120	1,270	1,275	450	122	158	254	21	85	

RECORD FOR JANUARY, 1890.

REGISTERED NAME.	Registered Number.	MILK PRODUCED.		WEIGHT OF COW.					FOOD CONSUMED.					Remarks.
		Pounds.	Ounces.	Third.	Tenth.	Seventeenth.	Twenty-fourth.	Thirty-first.	Timothy Hay.	Corn and Oat Meal.	Wheat Bran.	Cotton-Seed Meal.	Corn Stalks.	
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d....................	8,404	275	12	1,115	1,105	1,140	1,100	1,125	310	138	186	36	155	
Hattie Pearl..........................	8,241	837	4	905	880	910	900	935	310	186	186	62	155	
Young Duchess	9,285	776	10	825	850	875	860	875	310	186	186	62	155	
Guernsey—														
Cherry du Laurier 4th	2,240	263	14	1,025	1,010	1,065	1,030	1,195	310	93	93	31	155	
Ada	1,439	555	14	905	910	925	880	905	310	186	186	62	155	
Dolly Ford	1,595	501	5	975	990	1,010	1,000	1,020	310	186	186	62	155	
Holstein-Friesian—														
Jewel 3d..................................	2,188	111	10	1,415	1,405	1,375	1,425	1,430	465	91	191	10	155	
Evadne...................................	5,005	584	14	1,330	1,325	1,355	1,325	1,375	465	186	310	62	155	
Benola Fletcher......................	6,891	1,278	5	1,200	1,175	1,225	1,140	1,180	465	198	310	62	155	
Jersey—														
Annie Dale's Princess.	12,664	406	......	955	940	1,010	995	1,020	310	186	186	62	155	
Doecheco................................	14,574	403	8	915	905	935	930	935	310	186	186	62	155	
Hero's Blossom.	29,245	499	6	880	880	915	880	890	310	186	186	62	155	
Short-Horn—	A. H. B.													
Yarico Lass 8th of Mansfield...	Vol. 23	436	6	1,195	1,190	1,235	1,210	1,240	310	186	186	62	155	
Helen Mansfield......................	Vol. 21	317	14	1,240	1,235	1,290	1,260	1,305	310	186	186	62	155	
Nettie Mansfield.....................	Vol. 20	Dry.	......	1,280	1,320	1,320	1,305	1,345	310	......	186	......	155	

RECORD FOR FEBRUARY, 1890.

Registered Name.	Registered Number.	Milk Produced: Pounds.	Milk Produced: Ounces.	Weight of Cow: Seventh.	Weight of Cow: Fourteenth.	Weight of Cow: Twenty-first.	Weight of Cow: Twenty-eighth.	Food Consumed: Timothy Hay.	Food Consumed: Corn and Oat Meal.	Food Consumed: Wheat Bran.	Food Consumed: Corn Ensilage.	Food Consumed: Cotton-Seed Meal.	Food Consumed: Dried Brewers' Grains.	Food Consumed: Carrots.	Remarks.
				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Ayrshire—															
Miss Cornelia 2d	8,404	1	.....	1,115	1,125	1,105	1,130	280	.....	84	280	......	84	.....	Stopped milking February 3d.
Hattie Pearl	8,241	712	8	910	905	905	900	280	168	84	390	56	84	......	
Young Duchess	9,285	682	2	870	895	895	885	280	168	84	390	56	84	....	
Guernsey—															
Cherry du Laurier 4th	2,240	157	2	1,050	1,070	1,080	1,085	280	34	18	290	12	18	......	
Ada	1,439	518	4	905	910	910	925	280	167	84	365	55	83	3	
Dolly Ford	1,595	483	2	990	1,005	1,000	1,000	280	168	84	395	56	84	....	
Holstein-Friesian—															
Jewel 3d	2,188	1	8	1,450	1,440	1,420	1,435	420	......	84	280	.....	84	......	Stopped milking February 3d.
Evadne	5,005	415	4	1,375	1,405	1,395	1,440	420	168	137	455	52	136	...	
Benola Fletcher	6,891	1,103	4	1,200	1,260	1,200	1,180	495	161	124	165	13	129	365	
Jersey—															
Annie Dale's Princess	12,664	177	2	1,000	1,030	1,000	1,025	280	117	61	355	38	81	......	
Doecheco	14,574	247	14	945	965	975	935	280	163	81	400	49	83	......	
Hero's Blossom	29,245	437	14	895	895	855	870	280	168	84	400	56	83	....	Served February 17th.
Short-Horn—	A. H. B.														
Yarico Lass 8th of Mansfield	Vol. 23	314	6	1,225	1,255	1,265	1,280	280	168	84	400	56	84	..	
Helen Mansfield	Vol. 21	201	.....	1,285	1,280	1,295	1,320	280	162	84	400	......	84	....	
Nettie Mansfield	Vol. 20	Dry.	.....	1,325	1,355	1,355	1,340	280	......	78	245	.....	80	....	

RECORD FOR MARCH, 1890.

REGISTERED NAME.	Registered Number.	MILK PRODUCED Pounds.	Ounces.	WEIGHT OF COW. Seventh.	Fourteenth.	Twenty-first.	Twenty-eighth.	FOOD CONSUMED. Timothy Hay.	Corn and Oat Meal.	Wheat Bran.	Corn Ensilage.	Cut Stalks.	Cotton-Seed Meal.	Dried Brewers' Grains.	Carrots.	Remarks.
				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Ayrshire—																
Miss Cornelia 2d	8,404	Dry.	.....	1,140	1,160	1,155	1,200	310	.....	144	110	100	....	9	....	
Hattie Pearl	8,241	759	6	925	915	965	960	310	166	177	110	98	62	9	......	
Young Duchess	9,285	590	12	875	830	875	865	310	163	173	90	98	58	9	.....	Not well during the latter part of the month.
Guernsey—																
Cherry du Laurier 4th	2,240	Dry.	.....	1,075	1,065	1,125	1,125	310	....	60	110	100	....	....	......	Stopped milking Mar. 4th.
Ada	1,439	500	12	885	880	960	970	310	88	93	110	100	52	9	135	
Dolly Ford	1,595	493	8	1,005	975	1,025	1,020	310	166	177	110	100	62	9	5	
Holstein-Friesian—																
Jewel 3d	2,188	Dry.	.....	1,425	1,420	1,465	1,460	465	.....	132	110	100	......	9	......	
Evadne	5,005	273	.....	1,405	1,360	1,430	1,425	465	49	174	100	100	11	15	......	
Benola Fletcher	6,891	1,255	6	1,160	1,150	1,280	1,240	465	166	295	110	100	56	15	140	
Jersey—																
Annie Dale's Princess	12,664	6	8	1,015	1,040	1,075	1,090	310	13	85	100	100	2	3	....	Stopped milking Mar. 6th.
Doecheco	14,574	72	14	965	950	975	980	310	71	89	110	100	15	5	......	Stopped milking Mar. 30th.
Hero's Blossom	29,245	432	.....	875	875	940	905	310	166	177	110	100	56	9	....	
Short-Horn—	A. H. B.															
Yarico Lass 8th of Mansfield	Vol. 23	158	4	1,290	1,240	1,335	1,325	310	123	132	110	100	40	9	......	
Helen Mansfield	Vol. 21	43	8	1,325	1,310	1,340	1,340	310	36	90	110	100	2	9	......	Stopped milking Mar. 17th.
Nettie Mansfield	Vol 20	Dry.	.....	1,325	1,330	1,375	1,325	300	....	87	100	100	...	3	......	

RECORD FOR APRIL, 1890.

REGISTERED NAME.	Registered Number.	MILK PRODUCED: Pounds.	MILK PRODUCED: Ounces.	WEIGHT OF COW: Fourth.	WEIGHT OF COW: Eleventh.	WEIGHT OF COW: Eighteenth.	WEIGHT OF COW: Twenty-fifth.	FOOD CONSUMED: Timothy Hay.	FOOD CONSUMED: Corn and Oat Meal.	FOOD CONSUMED: Wheat Bran.	FOOD CONSUMED: Cut Stalks.	FOOD CONSUMED: Cotton-Seed Meal.	FOOD CONSUMED: Roots.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 2d	8,404	Dry.	.....	1,185	1,240	1,175	1,150	270	......	81	65	.....	......	Dropped bull calf April 26th. Died with milk fever April 29th.
Hattie Pearl	8,241	656	6	965	970	960	925	300	180	180	65	60	100	
Young Duchess	9,285	563	2	895	905	845	825	293	136	156	65	32	35	Not well during the whole month.
Guernsey—														
Cherry du Laurier 4th	2,240	382	6	1,095	1,150	980	970	300	36	123	65	......	45	Dropped bull calf April 15th.
Ada	1,439	533	8	950	960	955	940	300	90	90	65	45	100	
Dolly Ford	1,595	528	3	1,055	1,045	1,030	1,005	300	180	180	65	60	100	
Holstein-Friesian—														
Jewel 3d	2,188	Dry.	.....	1,455	1,455	1,440	1,425	450	......	90	65	......	......	
Evadne	5,005	94	4	1,450	1,460	1,425	1,380	450	.....	111	65	......	20	
Benola Fletcher	6,891	1,199	10	1,250	1,275	1,255	1,225	450	180	300	65	60	100	
Jersey—														
Annie Dale's Princess	12,664	429	4	1,350	....	955	900	300	66	117	65	......	68	Dropped heifer calf April 11th.
Doecheco	14,574	Dry.	....	1,000	1,025	910	985	300	......	90	65	......	......	
Hero's Blossom	29,245	439	2	940	950	920	910	300	180	180	65	60	100	
Short-Horn—	A. H. B.													
Yarico Lass 8th of Mansfield	Vol. 23	Dry.	.....	1,350	1,365	1,335	1,275	300	......	90	65	......	......	Stopped milking April 1st.
Helen Mansfield	Vol. 21	Dry.	.....	1,360	1,390	1,350	1,325	300	.....	90	65	.....	......	
Nettie Mansfield	Vol. 20	727	8	... ..	1,165	1,125	1,230	300	150	165	65	36	75	Dropped heifer calf April 4th.

RECORD FOR MAY, 1890.

REGISTERED NAME.	Registered Number.	MILK PRODUCED		WEIGHT OF COW.					FOOD CONSUMED.							Remarks.
		Pounds.	Ounces.	Second.	Ninth.	Sixteenth.	Twenty-third.	Thirtieth.	Hay.	Corn and Oat Meal.	Wheat Bran.	Green Fodder.	Cotton-Seed Meal.	Linseed Meal.	Beets.	
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Hattie Pearl..	8,241	422	8	925	905	980	950	995	104	173	123	680	5	27	95	The green fodder consisted of rye, wheat and orchard grass.
Young Duchess	9,285	651	6	815	800	775	825	850	103	133	109	755	....	8	......	
Guernsey—																
Cherry du Laurier 4th	2,240	961	6	925	935	925	8 ·5	910	103	179	123	755	....	46	95	
Ada	1,439	662	12	915	940	875	925	900	103	101	93	755	5	41	95	
Dolly Ford	1,595	604	2	1,025	1,020	1,015	975	960	104	183	120	755	5	45	95	
Holstein-Friesian.																
Jewel 3d	2,188	Dry.	.....	1,375	1,340	1,375	1,400	1,375	160	......	93	680	......	....	....	
Evadne	5,005	9	.....	1,380	1,380	1,370	1,380	1,400	159	....	93	680	....	....	......	Stopped milking May 5th.
Benola Fletcher...	6,981	1,188	2	1,230	1,215	1,190	1,225	1,250	158	199	245	770	5	45	95	
Jersey—																
Annie Dale's Princess.	12,664	1,091	4	860	820	820	850	835	102	188	119	755	......	5	95	
Doecheco	14,574	Dry.	.....	970	975	1,000	1,040	1,035	101	....	93	680	....	....	......	
Hero's Blossom	29,245	531	14	880	880	885	925	920	102	194	113	755	5	41	95	Dropped calf at 3 months, 13 days, on 30th.
Short-Horn—	A. H. B.															
Yarico Lass 8th of Mansfield..	Vol. 23	Dry.	.....	1,290	1,250	1,285	1,260	1,275	104	......	93	680	......	......	.....	
Helen Mansfield	Vol. 21	Dry.	.....	1,280	1,280	1,325	1,330	1,340	106	......	93	680	....	.....	....	
Nettie Mansfield	Vol. 20	1,168	2	1,100	1,075	1,050	1,055	1,075	105	202	145	755	5	4	95	

RECORD FOR JUNE, 1890.

Registered Name.	Registered Number.	Milk Produced: Pounds.	Milk Produced: Ounces.	Weight of Cow: Sixth.	Weight of Cow: Thirteenth.	Weight of Cow: Nineteenth.	Weight of Cow: Twenty-sixth.	Food Consumed: Corn and Oat Meal.	Food Consumed: Wheat Bran.	Food Consumed: Green Fodder.	Food Consumed: Dried Brewers' Grain.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 3d	8,934	783	6	960	1,025	1,035	1,030	142	134	1,205	75	Arrived at noon, June 5th.
Hattie Pearl	8,241	55	4	995	1,025	1,030	1,030	4	90	1,275	....	Stopped milking June 13th.
Young Duchess	9,285	724	14	840	895	900	875	154	90	1,335	130	
												The green fodder consisted of cut clover, timothy and alfalfa.
Guernsey—												
Cherry du Laurier 4th	2,240	833	2	920	965	950	930	158	90	1,335	130	
Ada	1,439	623	2	920	925	935	935	117	90	1,335	130	
Dolly Ford	1,595	616	8	980	990	1,000	990	158	90	1,335	130	
Holstein-Friesian—												
Jewel 3d	2,188	Dry.	.....	1,385	1,440	1,425	1,420	.....	90	1,340	54	
Evadne	5,005	997	10	1,225	1,225	1,160	1,170	56	90	1,370	60	Dropped bull calf June 4th; calf taken off June 16th.
Benola Fletcher	6,891	629	...	1,230	1,275	1,310	1,320	159	132	1,450	156	
Jersey—												
Annie Dale's Princess	12,664	1,108	2	835	855	875	845	158	90	1,335	130	
Doecheco	14,574	Dry.	.....	1,075	1,090	1,100	1,155	....	90	1,275	....	
Hero's Blossom	29,245	458	8	915	940	915	915	126	90	1,335	104	
Short-Horn—	A. H. B.											
Yarico Lass 8th of Mansfield	Vol. 23	Dry.	.....	1,290	1,290	1,300	1,290	....	90	1,275	....	
Helen Mansfield	Vol. 21	901	12	1,200	1,200	1,185	1,155	96	107	1,275	91	Calf taken off June 16th.
Nettie Mansfield	Vol. 20	1,045	2	1,085	1,075	1,125	1,100	164	128	1,450	151 10 oz.	

RECORD FOR JULY, 1890.

REGISTERED NAME.	Registered Number.	MILK PRODUCED. Pounds.	Ounces.	WEIGHT OF COW. Third.	Tenth.	Seventeenth.	Twenty-fourth.	Thirtieth.	FOOD CONSUMED. Corn and Oat Meal.	Wheat Bran.	Green Fodder.	Dried Brewers' Grain.	Remarks.
Ayrshire—				lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 3d	8,934	783	......	1,100	1,050	1,045	1,020	1,000	155	90	1,310	155	The green fodder consisted of clover, timothy, rye and corn. All the cows had pasture on the 30th and 31st.
Hattie Pearl	8,241	Dry.	...	1,060	1,050	1,050	1,035	1,000	..	27	1,305		
Young Duchess	9,285	530	6	925	900	915	925	915	155	93	1,305	155	
Guernsey—													
Cherry du Laurier 4th	2,240	767	....	985	930	950	950	905	155	93	1,305	155	
Ada	1,439	534	...	975	950	945	915	925	124	93	1,305	149	
Dolly Ford	1,595	569	2	1,025	1,000	1,010	975	990	155	93	1,305	155	
Holstein-Friesian—													
Jewel 3d	2,188	354	8	1,425	1,350	1,425	1,355	1,300	57	93	1,400	93	
Evadne	5,005	1,614	6	1,200	1,190	1,220	1,160	1 215	173	118	1,400	156	
Benola Fletcher	6,891	135	12	1,365	1,300	1,335	1,350	1,275	71	51	1,400	65	
Jersey—													
Annie Dale's Princess	12,664	986	14	900	870	875	875	840	155	93	1,305	155	
Doecheco	14,574	Dry.	......	1,100	....	....	....	....	......	18	360	......	Dropped heifer calf on the 7th. Taken with milk fever and died on the 9th.
Hero's Blossom	29,245	421	12	955	940	950	925	940	93	93	1,305	93	
Short-Horn—	A. H. B.												
Yarico Lass 8th of Mansfield	Vol. 23	Dry.	......	1,340	1,320	1,350	1,215	1,050	......	30	935	.....	Dropped bull calf July 19th.
Helen Mansfield	Vol. 21	1,246	.....	1,175	1,125	1,150	1,150	1,185	132	120	1,385	155	
Nettie Mansfield	Vol. 20	892	2	1,150	1,100	1,100	1,125	1,100	155	124	1,385	186	

RECORD FOR AUGUST, 1890.

REGISTERED NAME.	Registered Number.	Milk Produced: Pounds.	Milk Produced: Ounces.	Weight of Cow: Eighth.	Weight of Cow: Fifteenth.	Weight of Cow: Twenty-second.	Weight of Cow: Twenty-ninth.	Food Consumed: Corn Meal.	Food Consumed: Wheat Bran.	Food Consumed: Corn Fodder.	Food Consumed: Dried Brewers' Grain.	Remarks.
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Miss Cornelia 3d	8,934	485	3	1,085	965	915	905	42½	93½	1,000	42½	Attacked with garget on the 9th.
Hattie Pearl	8,241	513	2	885	850	825	805	45	95	1,350	21	Dropped heifer calf on 3d. Calf taken off on 26th.
Young Duchess	9,285	349	8	950	910	915	900	104	104	1,350	115	
Guernsey—												
Cherry du Laurier 4th	2,240	659	10	910	905	885	1,000	114	93	1,350	155	(All cows had pasture until the 5th, and Miss Cornelia 3d from 25th to 31st.)
Ada	1,439	367	12	925	910	900	1,000	3	42	870	6	
Dolly Ford	1,595	516	6	990	960	950	955	114	93	1,350	155	
Holstein-Friesian—												
Jewel 3d	2,188	716	6	......	......	......	......	121	93	1,620	133	
Evadne	5,005	1,424	4	1,175	1,140	1,160	1,105	152	124	1,620	155	
Benola Fletcher	6,891	Dry.	......	1,260	1,200	1,290	1,280	......	......	1,350	......	
Jersey—												
Annie Dale's Princess.	12,664	877	14	865	835	825	825	116	93	1,350	155	
Hero's Blossom.	29,245	383	14	955	905	900	895	81	93	1,350	115	
Short-Horn—	A. H. B.											
Yarico Lass 8th of Mansfield	Vol. 23	30	......	1,060	1,100	1,060	1,055	......	44	350	......	
Helen Mansfield	Vol. 21	1,056	14	1,140	1,075	1,075	1,075	116	104	1,350	155	
Nettie Mansfield	Vol. 20	816	10	1,110	1,060	1,050	1,055	133	107	1,350	165	

RECORD FOR SEPTEMBER, 1890.

Registered Name.	Registered Number.	Milk Produced: Pounds.	Milk Produced: Ounces.	Weight of Cow: Fifth.	Weight of Cow: Twelfth.	Weight of Cow: Twentieth.	Weight of Cow: Twenty-seventh.	Food Consumed: Hay.	Food Consumed: Corn Meal.	Food Consumed: Wheat Bran.	Food Consumed: Corn Fodder.	Food Consumed: Dried Brewers' Grain.	Remarks.
				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Ayrshire—													
Miss Cornelia 3d	8,934	431	2	965	940	982	965	70	.....	120	1,570	38	
Hattie Pearl	8,241	1,086	8	845	815	830	835	.....	60	120	1,770	84	
Young Duchess	9,285	20	8	940	935	955	920	......	......	53	1,770	......	
Guernsey—													
Cherry du Laurier 4th	2,240	539	2	940	930	930	915	......	60	90	1,770	150	
Ada	1,439	75	.....	935	920	915	....	133	......	40	1,410	......	Dropped bull calf September 25th.
Dolly Ford	1,595	435	6	995	965	998	940	......	60	90	1,770	150	
Holstein-Friesian—													
Jewel 3d	2,188	569	10	1,300	1,275	1,285	1,285	......	93	90	2,070	150	
Evadne	5,005	1,141	.....	1,155	1,140	1,145	1,250	......	93	120	2,070	150	
Benola Fletcher	6,891	Dry.	.....	1,290	1,255	1,270	1,245	......	......	....	2,070	....	
Jersey—													
Annie Dale's Princess	12,664	803	12	880	830	848	815	......	63	90	1,770	150	
Hero's Blossom.	29,245	17	6	......	....	....	....	......	4	6	100	10	Returned to owner September 2d.
Short-Horn—	A. H. B.												
Yarico Lass 8th of Mansfield	Vol. 23	728	4	1,000	1,030	1,055	1,010	......	56	120	1,770	98	
Helen Mansfield	Vol. 21	747	14	1,100	1,065	1,080	1,050	......	59	91½	1,770	142½	Not well from 10th to 14th.
Nettie Mansfield	Vol. 20	665	4	1,095	1,065	1,075	1,060	.....	66	108	1,770	150	

RECORD FOR OCTOBER, 1890.

Registered Name.	Registered Number.	Milk Produced.		Weight of Cow.			Food Consumed.						Remarks.
		Pounds.	Ounces.	Fourth.	Eleventh.	Thirty-first.	Hay.	Corn Meal.	Wheat Bran.	Corn Fodder.	Dried Brewers' Grain.	Pasture.	
Ayrshire—				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	h'rs	
Miss Cornelia 3d	8,934	482	4	960	1,000	1,045	280	84	124	60	103	56	
Hattie Pearl	8,241	1,062	10	830	840	905	280	88	124	180	93	56	
Young Duchess	9,285	43	......	945	960	710	150	......	7	180	.....	56	Dropped bull calf October 16th. Taken with puerperal apoplexy, but was much improved on 26th.
Guernsey—													
Cherry du Laurier 4th	2,240	492	10	920	950	940	280	88	81	180	103	56	
Ada	1,439	573	12	805	810	800	280	64	124	180	....	56	Calf taken off October 16th.
Dolly Ford	1,595	422	14	960	985	1,000	280	88	93	180	103	56	
Holstein-Friesian.													
Jewel 3d	2,188	268	15	1,275	1,308	1,350	380	69	94	210	155	56	
Evadne	5,005	1,130	10	1,135	1,153	1,195	280	93	124	210	155	56	
Benola Fletcher	6,891	625	6	1,260	1,318	1,135	280	24	86	210	......	56	Dropped heifer calf October 11th. Calf taken off October 17th.
Jersey—													
Annie Dale's Princess	12,664	698	14	850	868	915	280	88	93	180	103	56	
Short-Horn.	A. H. B.												
Yarico Lass 8th of Mansfield	Vol. 23	814	14	1,035	1,060	1,075	280	88	124	180	103	56	
Helen Mansfield	Vol. 21	383	4	1,100	1,065	1,110	280	7	99	180	10	56	Sick with garget until October 8th.
Nettie Mansfield	Vol. 20	598	8	1,040	1,100	1,180	280	88	124	180	103	56	

RECORD OF ANALYSES OF MILK FROM INDIVIDUAL COWS OF EACH HERD FOR AUGUST, 1889.

DATE.	PERCENTAGE OF TOTAL SOLIDS.														
	AYRSHIRE.			GUERNSEY.			HOLSTEIN-FRIESIAN.			JERSEY.			SHORT-HORN.		
	Miss Cornelia 2d.	Hattie Pearl.	Young Duchess.	Dairymaid 3d.	Ada.	Dolly Ford.	Jewel 3d.	Evadne.	Benola Fletcher.	Annie Dale's Princess.	Doecheco.	Hero's Blossom.	Yarico Lass 8th.	Helen Mansfield.	Nettie Mansfield 3d.
August 3	12.67	10.24					12.01								
" 7													11.58	11.32	11.47
" 8				12.47	12.97	12.35				13.08	13.21				
" 12	12.57	10.85					12.27								
" 14										13.42	12.85		11.70	11.85	11.81
" 16				13.42	13.40	12.88									
" 19	12.44	10.84					12.22			13.52	13.52				
" 21				13.02	13.17	13 32							12.13	12.22	12.13
" 23	12.66	11.23								13.56	13.21				
" 26				13.12	13.18	13.11							12.53	12.37	12.20
" 28	12.52	11.41					12.73			13.81	13.17				
" 30				12.69	13.57	13.17							12.44	12.22	12.29
Average of month	12.57	10.91		12.94	13.26	12.97	12.31			13.48	13.19		12.08	12.20	11.98

RECORD OF ANALYSES OF MILK OF INDIVIDUAL COWS OF EACH HERD FOR SEPTEMBER, 1889.

DATE.	PERCENTAGE OF TOTAL SOLIDS.														
	AYRSHIRE.			GUERNSEY.			HOLSTEIN-FRIESIAN.			JERSEY.			SHORT-HORN.		
	Miss Cornelia 2d.	Hattie Pearl.	Young Duchess.	Dairymaid 3d.	Ada.	Dolly Ford.	Jewel 3d.	Evadne.	Benola Fletcher.	Annie Dale's Princess.	Doecheco.	Hero's Blossom.	Yarico Lass 8th.	Helen Mansfield.	Nettie Mansfield 3d.
September 2	12.74	11.66	......	......	......	......	......	......	......	13.92	13.78	......	......	......	......
" 4	......	......	......	12.94	13.76	13.64	......	12.73	......	......	......	14.38	12.32	12.16	12.30
" 6	12.65	11.49	......	......	......	......	......	......	......	14.01	13.39	12.47	......	......	......
" 9	......	......	......	13.38	13.75	13.12	......	......	......	......	......	......	12.61	12.36	12 22
" 11	......	......	......	......	......	......	12.60	12.07	......	13.89	13.11	13.11	......		......
" 13	12.40	11.61	......	......	......	......	......	......	......	......	......	......	12.46	11.90	12.09
" 17	......	......	......	13.03	13.75	13.33	12.93	11.88	......	......	......	......	......	......	......
" 19	13.27	12.01	......	......	......	......	......	......	......	14.23	13.75	13.69	......	......	......
" 21	......	......	......	......	......	......	13.79	12.10	......	......	......	......	......	......	......
" 24	13.04	11.87	......	13.34	13.99	14.40	......	......	......	......	......	......	......	......	......
" 27	......	......	......	......	......	......	......	......	......	14.65	13.47	13.66	12.43	12.19	12.57
" 30	13.17	11.53	......	......	......	......	13.74	12.48	......	......	......	......	......	......	......
Average of month	12.88	11.70	......	13.17	13.81	13.62	13.27	12.25	......	14.14	13.44	13.46	12.46	12.15	12.30

RECORD OF ANALYSES OF MILK OF HERD.

Month of August, 1889.

DATE.	PERCENTAGE OF TOTAL SOLIDS. HERD. Ayrshire.	Guernsey.	Holstein-Friesian.	Jersey.	Short-Horn.
July 30	11.09	12.35	11.92	12.40	11.58
August 1	11.72	12.50	11.87	13.01	11.84
" 6	11.63	12.57	12.14	12.96	11.65
" 8	11.45	12.51	12.09	13.15	11.82
" 10	11.51	12.80	11.64	12.92	11.79
" 13	11.42	12.48	12.27	12.94	11.70
" 15	11.38	13.07	11.81	13.14	12.17
" 17	11.87	13.52	12.28	13.61	12.31
" 20	11.90	13.41	12.22	13.80	12.36
" 22	12.01	13.31	12.18	13.59	12.32
" 24	12.20	13.18	12.20	13.79	12.48
" 27	12.05	13.36	13.02	13.71	12.30
" 29	11.94	13.20	12.44	13.48	12.14
" 31	11.80	12.92	12.14	13.74	12.38
Average of month	11.76	12.99	12.18	13.37	12.10

Month of September, 1889.

DATE.	Ayrshire.	Guernsey.	Holstein-Friesian.	Jersey.	Short-Horn.
September 3	12.02	13.28	12.32	13.68	11.92
" 5	12.11	13.27	12.25	13.41	12.35
" 7	11.74	13.23	12.16	13.23	12.25
" 10	11.95	13.20	12.45	13.35	12.04
" 12	12.06	13.26	12.33	13.45	12.16
" 16	12.18	13.41	12.06	13.84	11.78
" 18	12.38	13.89	12.39	13.80	12.52
" 20	12.43	13.92	12.57	13.95	12.46
" 23	12.16	13.54	12.82	13.54	12.85
" 26	12.71	14.09	12.88	14.20	12.70
" 28	12.34	14.04	12.72	14.20	12.47
Average of month	12.19	13.56	12.45	13.70	12.32

Month of November, 1889.

DATE.	Ayrshire.	Guernsey.	Holstein-Friesian.	Jersey.	Short-Horn.
November 2	12.45	14.17	12.38	14.22	12.64
" 5	12.29	14.25	12.55	14.46	12.96
" 6	13.18	14.95	12.54	14.99	13.18
" 8	12.60	14.43	12.16	14.93	13.18
" 12	12.65	14.13	12.31	13.16	12.94
" 14	12.20	14.13	11.92	14.40	12.89
" 15	12.21	14.40	12.16	14.70	13.09
" 18	12.59	14.46	12.03	15.50	12.88
" 20	12.37	14.40	12.47	14.72	13.06
" 21	12.18	14.03	12.22	14.53	13.04
" 23	12.20	13.98	12.05	14.87	12.61
" 27	12.40	14.11	12.26	14.46	12.83
" 29	12.44	14.17	12.44	14.65	13.02
Average of month	12.44	14.28	12.27	14.58	12.95

RECORD OF ANALYSES OF MILK OF HERD FOR DECEMBER, 1889.

DATE.	AYRSHIRE.			GUERNSEY.			HOLSTEIN-FRIESIAN.			JERSEY.			SHORT-HORN.		
	Percentage of			Percentage of			Percentage of			Percentage of			Percentage of		
	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.		Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.
December 2	12.63	3.60	9.03	14.44	4.75	9.60	12.28	3.45	8.83	14.86	4.79	10.07	13.07	3.85	9.22
" 9	12.75	3.74	9.01	14.65	5.08	9.57	12.53	3.46	9.07	15.07	5.21	9.86	13.01	3.76	9.25
" 11	12.57	3.76	8.81	14.57	5.19	9.38	12.13	3.61	8.52	14.70	5.14	9.56	12.64	3.60	9.04
" 13	12.29	3.46	8.83	14.38	4.90	9.48	12.26	3.63	8.63	14.67	5.02	9.65	12.84	3.90	8.94
" 18	12.49	3.57	8.92	14.27	4.84	9.43	12.25	3.67	8.58	14.40	4.76	9.64	12.98	4.02	8.96
" 20	12.49	3.28	9.21	14.94	5.49	9.45	12.44	3.94	8.50	14.55	5.23	9.32	12.93	3.91	9.02
" 23	12.52	3.53	8.99	14.86	5.21	9.65	12.12	3.61	8.51	14.71	4.97	9.74	12.79	3.83	8.96
" 24	12.63	3.82	8.81	14.65	5.14	9.51	12.15	3.66	8.49	14.93	5.14	9.79	12.73	3.73	9.00
" 30	12.64	3.75	8.89	15.02	5.42	9.60	12.18	3.70	8.48	14.66	4.96	9.70	12.71	3.72	8.99
Average of month	12.55	3.61	8.94	14.64	5.11	9.53	12 26	3.64	8.62	14.72	5.02	9.70	12.85	3.81	9.04

RECORD OF ANALYSES OF MILK OF HERD FOR JANUARY, 1890.

DATE.	AYRSHIRE.			GUERNSEY.			HOLSTEIN-FRIESIAN.			JERSEY.			SHORT-HORN.		
	Percentage of			Pe[illegible]			Percentage of			Percentage of			Percentage of		
	Total Solids.	Fat.	Solids not Fat.	Total Solids.	[illegible]	[illegible]	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.
January 6	13.01	3.84	9.17	15.39	5.59	9.80	12.21	3.74	8.47	15.26	5.27	9.99	13.27	4.00	9.27
" 8	12.94	3.84	9.10	15.33	5.62	9.71	12.08	3.64	8.44	15.08	5.12	9.96	13.30	4.21	9.09
" 10	12.96	3.86	9.10	15.16	5.42	9.74	12.18	3.67	8.51	15.02	5.19	9.83	13.56	4.45	9.11
" 13	13.08	4.16	8.92	15.08	5.40	9.68	12.24	3.80	8.44	14.92	5.21	9.71	13.30	4.13	9.17
" 15	12.91	3.87	9.04	15.04	5.33	9.71	12.23	3.63	8.60	14.83	5.04	9.79	13.30	4.28	9.02
" 17	12.94	3.88	9.06	15.20	5.53	9.67	12.28	3.77	8.51	15.31	5.42	9.89	13.50	4.27	9.23
" 20	12.90	3.98	8.92	15.45	5.68	9.77	12.22	3.74	8.48	15.32	5.44	9.88	13.70	4.65	9.05
" 22	12.92	3.70	9.22	15.30	5.60	9.70	12.27	3.61	8.66	15.16	5.22	9.94	13.61	4.25	9.36
" 24	13.14	3.88	9.26	15.54	5.58	9.96	12.39	3.67	8.72	15.38	5.28	10.10	13.29	4.18	9.11
" 27	12.87	3.72	9.15	15.47	5.48	9.99	12.31	3.69	8.62	15.37	5.23	10.14	13.70	4.30	9.40
" 29	12.49	3.54	8.95	15.39	5.44	9.95	12.42	3.62	8.80	15.32	5.08	10.24	13.13	4.08	9.05
" 31	12.47	3.53	8.94	15.17	5.29	9.88	12.30	3.55	8.75	15.41	5.29	10.12	13.58	4.31	9.27
Average of month	12.88	3.81	9.07	15.29	5.49	9.80	12.26	3.68	8.58	15.19	5.23	9.96	13.44	4.26	9.18

RECORD OF ANALYSES OF MILK OF HERD FOR FEBRUARY, 1890.

DATE.	AYRSHIRE.			GUERNSEY.			HOLSTEIN-FRIESIAN.			JERSEY.			SHORT-HORN.		
	Percentage of			Percentage of			Percentage of			Percentage of			Percentage of		
	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.
February 3	12.71	3.77	8.94	15.17	5.36	9.81	12.45	3.75	8.70	15.17	5.34	9.83	13 65	4.50	9.15
" 5	12.64	3.53	9.11	15.23	5.21	10.02	12.53	3.81	8.74	15.18	5.16	10.02	13.54	4.10	9.44
" 7	12.76	3.53	9.23	15.26	5.33	9.93	12.08	3.42	8.66	15.27	5.28	9.99	13.34	3.90	9.44
" 10	12.66	3.71	8.95	15.17	5.36	9.81	12.36	3.60	8.69	15.11	5.15	9.96	13.47	4.15	9.32
" 12	12.77	3.85	8.92	15.26	5.35	9.91	12.76	3.96	8.80	15.21	5.20	10.01	13.65	4.50	9.15
" 14	12.85	3.94	8.91	15.28	5.48	9.80	12.38	3.65	8.73	15.20	5.27	9.93	13.46	4.19	9.27
" 17	12.85	3.81	9.04	15.12	5.26	9.86	12.43	3.74	8.69	15.70	5.58	10.12	14.01	4.71	9.31
" 19	12.73	3.70	9.03	15.13	5.20	9.93	12.29	3.61	8 68	15.88	5.56	10.33	13.79	4.35	9.44
" 21	12.62	3.71	8.91	14.78	5.13	9.65	12.19	3.80	8.39	15.22	5.34	9.88	13.70	4.53	9.17
" 24	13.29	4.03	9.26	15.64	5.70	9.94	12.60	3.80	8.80	15.49	5.30	10.19	14.07	4.77	9.30
" 26	12.69	3.70	8.99	14.65	5.10	9.55	12.37	3.73	8.68	15.00	5.22	9.78	13.72	4.48	9.27
" 28	12.57	3.69	8.88	15.08	5.31	9.77	12.36	3.80	8.56	14.99	5.25	9.74	14.44	5.19	9.25
Average of month	12.76	3.75	9.01	15.15	5.32	9.83	12.41	3.73	8.68	15.29	5.31	9.98	13.74	4.45	9.29

RECORD OF ANALYSES OF MILK OF AYRSHIRES FOR MARCH AND APRIL, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March 3	1.033	87.13	12.87	3.80	3.50	5.01	0.56	April 2	1.0340	86.96	13.04	3.83	4.19	4.35	0.67
" 5	1.0340	87.13	12.87	3.89	2.97	5.33	0.68	" 4	1.0340	86.96	13.04	3.84	3.91	4.58	0.71
" 7	1.0350	87.12	12.88	4.16	3.69	4.32	0.71	" 7	1.0345	86.92	13.08	3.96	3.94	4.47	0.71
" 10	1.0350	86.98	13.02	4.01	3.38	4.87	0.76	" 9	1.0340	86.86	13.14	3.87	4.22	4.34	0.71
" 12	1.0330	86.60	13.40	4.49	3.03	5.21	0.67	" 11	1.0340	87.02	12.98	3.75	3.94	4.61	0.68
" 14	1.0335	87.15	12.85	3.90	3.31	4.95	0.69	" 14	1.0335	86.94	13.06	3.90	3.91	4.52	0.73
" 17	1.0330	87.13	12.87	4.00	3 34	4.89	0.64	" 16	1.0345	86.44	13.56	4.20	3.69	4.95	0.72
" 19	1.0359	86.92	13.08	4.03	3.38	4.96	0.71	" 21	1.0338	87.26	12.74	3.65	3.31	5.06	0.72
" 21	1.0350	86.94	13 06	3.97	3.28	5.15	0.66	" 23	1.0335	87.28	12.72	3.65	3.38	4.96	0.73
" 24	1.0335	86.99	13.01	3.86	3.56	4.89	0.70	" 25	1.0352	86.53	13.47	3.88	3.66	5.18	0.75
" 26	1.0335	87.34	12.66	3.64	3.84	4.50	0.68	" 28	1.0350	86.91	13.09	3.74	3.66	4.94	0.75
" 28	1.0345	86.86	13.14	3.73	3.66	5.04	0.71	" 30	1.0340	86 87	13.13	3.93	3.81	4.66	0.73
" 31	1.0340	86.77	13.23	3.92	3.69	4.97	0.65								
Average	**1.0341**	**87.00**	**13.00**	**3.95**	**3.44**	**4.93**	**0.68**	**Average**	**1.0342**	**86.91**	**13.09**	**3.85**	**3.80**	**4.72**	**0.72**

RECORD OF ANALYSES OF MILK OF AYRSHIRES FOR MAY AND JUNE, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF						DATE.	Specific Gravity.	PERCENTAGE OF					
		Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.			Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
May 2	1.0340	87.46	12.54	3.23	3.84	4.81	0 66	June 2	1.0345	87.75	12.25	2.90	3.56	5.07	0.72
" 5	1.0335	87.08	12 92	3.64	3.78	4.79	0.71	" 4	1.0360	87.36	12.64	3.21	3.47	5.25	0.71
" 7	1.0360	86.67	13.33	3.72	3.75	5.06	0.80	" 6	1.0348	87.77	12.23	3.26	3.16	5.12	0.69
" 9	1.0350	86.70	13.30	3.63	3.91	4.96	0.80	" 9	1.0350	87.26	12.74	3.70	3.03	5.84	0.67
" 12	1.0345	86.96	13.04	3.57	3.81	4.88	0 78	" 11	1.0360	87.55	12.45	3.35	3.22	5.22	0.66
" 14	1.0355	86.74	13.26	3.81	4.00	4.61	0.84	" 13	1.0365	86.96	13.04	3.58	3.22	5.56	0.68
" 16	1.0350	86.70	13.30	3.77	3.97	4.79	0.77	" 16	1.0340	87.39	12.61	3.46	3.22	5.23	0.70
" 19	1.0340	86.73	13.27	3.90	3.94	4.65	0.78	" 20	1.0355	87.25	12.75	3.73	3.25	5.10	0.67
" 21	1.0345	86.74	13.26	3.80	3.78	4.93	0.75	" 23	1.0345	87.29	12.71	3.64	3.16	5.24	0.67
" 23	1.0345	87.00	13.00	3.61	3.63	5.01	0.75	" 25	1.0355	87.60	12.40	3.28	3.19	5.20	0.73
" 26	1.0345	87.83	12.17	2.86	3.63	4.96	0.72	" 27	1.0345	87.29	12.71	3.64	3.34	5.09	0.64
" 28	1.0340	87.77	12.23	2.94	3.63	4.91	0.75	" 30	1 0350	87.53	12.47	3.35	3.50	5.02	0.60
Average	**1.0346**	**87.03**	**12.97**	**3.54**	**3.81**	**4.86**	**0.76**	**Average**	**1.0352**	**87.42**	**12.58**	**3.42**	**3.28**	**5.30**	**0.68**

RECORD OF ANALYSES OF MILK OF AYRSHIRES FOR JULY AND AUGUST, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
July 2	1.0340	87.52	12.48	3.40	3.56	4.86	0.66	August 1	1.0325	87.48	12.52	3.75	3.63	4.48	0.66
" 7	1.0345	87.21	12.79	3.75	3.25	5.14	0.65	" 4	1.0340	87.49	12.51	3.84	3.47	4.53	0.67
" 9	1.0355	87.59	12.41	3.39	3.34	5.05	0.63	" 6	1.0325	87.25	12.75	3.94	3.47	4.70	0.64
" 11	1.0330	87.19	12.81	3.66	3.31	5.21	0.63	" 8	1.0340	87.32	12.68	3.76	3.44	4.84	0.64
" 14	1.0340	87.32	12.68	3.76	3.75	4.53	0.64	" 11	1.0345	86.70	13.30	4.34	3.59	4.70	0.67
" 16	1.0340	87.39	12.61	3.76	3.69	4.51	0.65	" 13	1.0320	86.70	13.30	4.43	3.69	4.52	0.66
" 18	1.0325	87.36	12.64	3.86	3.53	4.62	0.63	" 15	1.0340	86.58	13.42	4.12	3.69	4.92	0.69
" 21	1.0345	87.34	12.66	3.56	3.59	4.86	0.65	" 18	1.0330	86.84	13.16	3.99	3.66	4.84	0.67
" 23	1.0335	86.77	13.23	3.94	3.72	4.90	0.67	" 20	1.0330	86.41	13.59	4.31	3.69	4.90	0.69
" 25	1.0330	87.16	12.84	3.65	3.69	4.78	0.72	" 22	1.0348	86.84	13.16	4.14	3.69	4.67	0.66
" 28	1.0335	87.28	12.72	3.89	3.66	4.50	0.67	" 25	1.0335	86.60	13.40	4.16	3.72	4.85	0.67
" 30	1.0320	87.25	12.75	3.88	3.66	4.54	0.67	" 27	1.0340	86.84	13.16	4.14	3.66	4.69	0.67
								" 29	1.0340	86.91	13.09	3.99	3.81	4.62	0.67
Average	**1.0337**	**87.28**	**12.72**	**3.71**	**3.56**	**4.79**	**0.66**	**Average**	**1.0335**	**86.92**	**13.08**	**4.07**	**3.63**	**4.68**	**0.67**

RECORD OF ANALYSES OF MILK OF AYRSHIRES FOR SEPTEMBER AND OCTOBER, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
September 17	1.0340	88.15	11.85	3.29	2.91	4.99	0.66
" 19	1.0335	87.98	12.02	3.34	3.19	4.80	0.69
" 22	1.0335	88.27	11.73	3.14	3.09	4.81	0.69
" 24	1.0340	88.34	11.66	3.13	3.28	4.57	0.68
" 26	1.0340	88.06	11.94	3.23	3.00	5.04	0.67
" 29	1.0320	88.06	11.94	3.43	3.16	4.55	0.70
Average	**1.0336**	**88.15**	**11.85**	**3.26**	**3.11**	**4.79**	**0.68**

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
October 1.	1.0340	88.28	11.72	3.03	3.06	4.97	0.66
" 3.	1.0345	87.32	12.68	3.88	3.22	4.89	0.69
" 6.	1.0295	88.94	11.06	3.20	2.97	4.23	0.66
" 8.	1.0340	87.47	12.53	3.63	3.19	5.00	0.71
" 10.	1.0335	87.66	12.34	3.66	3.34	4.59	0.75
" 13.	1.0332	87.38	12.62	3.91	3.28	4.72	0.71
" 15.	1.0335	87.38	12.62	3.76	3.41	4.75	0.70
" 17.	1.0335	87.79	12.21	3.49	3.16	4.88	0.68
" 20.	1.0335	87.48	12.52	3.79	3.22	4.81	0.70
" 24.	1.0335	87.54	12.46	3.65	3.31	4.78	0.72
" 27.	1.0330	87.80	12.20	3.58	3.25	4.66	0.71
" 29.	1.0340	87.93	12.07	3.42	3.31	4.63	0.71
" 31.	1.0330	87.48	12.52	3.75	3.41	4.65	0.71
Average	**1.0341**	**87.73**	**12.27**	**3.60**	**3.24**	**4.74**	**0.70**

RECORD OF ANALYSES OF MILK OF GUERNSEYS FOR MARCH AND APRIL, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March 3.	1.0345	84.55	15.45	5.59	4.38	4.80	0.68	April 2	1.0350	84.96	15.04	5.30	5.06	3.94	0.74
" 5.	1.0358	84.42	15.58	5.69	4.19	4.92	0.78	" 4	1.0355	84.94	15 06	5.23	4.78	4.30	0.75
" 7.	1.0355	84.86	15.14	5.54	4.09	4.73	0.78	" 7	1.0362	84.66	15.34	5.45	4.44	4.70	0.75
" 10.	1.0360	84.59	15.41	5.67	3.75	5.19	0.80	" 9	1.0350	84.88	15.12	5.32	4.69	4.33	0.78
" 12.	1.0360	84.63	15.37	5.39	4.25	4.98	0.75	" 11	1.0350	84.83	15.17	5.34	4.31	4.77	0.75
" 14.	1.0360	84.88	15.12	5.36	4.19	4.79	0.78	" 14	1.0350	85.16	14.84	5.15	4.41	4.48	0.80
" 17.	1.0350	84.62	15.38	5.74	4.41	4.47	0.76	" 16	1.0350	84.81	15.19	5.30	4.22	4.90	0.77
" 19.	1.0360	84.89	15.11	5.35	4.16	4.84	0.76	" 18	1.0347	85.03	14.97	5.38	4.31	4.52	0.76
" 21.	1.0370	84.65	15.35	5.55	4.28	4.80	0.72	" 21	1.0350	85.26	14.74	5.04	4.56	4.38	0.76
" 24.	1.0360	84 87	15.13	5.27	4.22	4.88	0.76	" 23	1.0350	85.33	14.67	4.92	4.00	4 98	0.77
" 26.	1.0355	85.05	14.95	5.20	4.50	4.53	0.72	" 25	1.0355	85.12	14.88	5.14	4.00	4.99	0.75
" 28.	1.0360	84.48	15.52	5.35	4.47	4.93	0.77	" 28	1.0350	85.28	14.72	5.07	4.06	4.84	0.75
" 31.	1.0350	84.76	15.24	5.36	4.59	4.55	0.74	" 30	1.0350	85 44	14.56	5 00	4.06	4.76	0.74
Average	**1.0357**	**84.71**	**15.29**	**5.46**	**4.27**	**4.80**	**0.76**	**Average**	**1.0351**	**85.05**	**14.95**	**5.20**	**4.37**	**4.62**	**0.76**

RECORD OF ANALYSES OF MILK OF GUERNSEYS FOR MAY AND JUNE, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
May 2	1.0350	85.88	14.12	4.47	4.13	4.78	0.74	June 2	1.0340	86.09	13.91	4.63	3.16	5.48	0.74
" 5	1.0340	85.70	14.30	4.74	4.19	4.65	0.72	" 4	1.0350	85.85	14.15	4.74	3.25	5.45	0.71
" 7	1.0345	86.14	13.86	4.39	4.22	4.53	0.72	" 6	1.0345	86.81	13.19	4.00	3.22	5.22	0.75
" 9	1.0345	86.34	13.66	4.33	4.16	4.46	0.71	" 9	1.0360	86.12	13.88	4.59	3.03	5.53	0.73
" 12	1.0345	85.89	14.11	4.54	4.28	4.55	0.74	" 11	1.0355	86.02	13.98	4.70	3.25	5.31	0.72
" 14	1.0348	85.70	14.30	4.81	4.47	4.28	0.74	" 13	1.0355	85.84	14.16	4.94	3.09	5.39	0.74
" 16	1.0340	86.06	13.94	4.51	4.22	4.48	0.73	" 16	1.0345	85.60	14.40	5.09	3.22	5.35	0.74
" 19	1.0345	85.92	14.08	4.59	4.34	4.44	0.71	" 20	1.0358	86.32	13.68	4.46	3.16	5.32	0.74
" 21	1.0340	86.24	13.76	4.33	4.34	4.40	0.69	" 23	1.0360	86.45	13.55	4.12	3.56	5.12	0.75
" 23	1.0345	85.90	14.10	4.82	4.25	4.33	0.70	" 25	1.0360	86.05	13.95	4.61	3.28	5.33	0.73
" 26	1.0345	86.21	13.79	4.59	3.84	4.64	0.72	" 27	1.0350	86.00	14.00	4.61	3.53	5.13	0.73
" 28	1.0338	86.06	13.94	4.70	3.22	5.29	0.73	" 30	1.0360	86.55	13.45	4.05	3.47	5.21	0.72
Average	**1.0344**	**86.00**	**14.00**	**4.57**	**4.14**	**4.57**	**0.72**	**Average**	**1.0353**	**86.14**	**13.86**	**4.55**	**3.27**	**5.32**	**0.73**

RECORD OF ANALYSES OF MILK OF GUERNSEYS FOR JULY AND AUGUST, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	PERCENTAGE OF Total Solids.	PERCENTAGE OF Fat.	PERCENTAGE OF Casein and Albumen.	PERCENTAGE OF Sugar.	PERCENTAGE OF Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	PERCENTAGE OF Total Solids.	PERCENTAGE OF Fat.	PERCENTAGE OF Casein and Albumen.	PERCENTAGE OF Sugar.	PERCENTAGE OF Ash.
July 2	1.0350	86.48	13.52	4.09	3.63	5.07	0.73	August 1	1.0345	86.25	13.75	4.61	3.59	4.82	0.73
" 7	1.0355	86.35	13.65	4.40	3.63	4.90	0.72	" 4	1.0350	86.11	13.89	4.66	3.63	4.84	0.76
" 9	1.0360	86.09	13.91	4.61	3.44	5.14	0.72	" 6	1.0345	85.66	14.34	5.45	3.50	4.68	0.71
" 11	1.0350	85.89	14.11	4.70	3.41	5.28	0.72	" 8	1.0345	86.36	13.64	4.68	3.44	4.83	0.69
" 14	1.0350	85.92	14.08	4.71	3.66	4.98	0.73	" 11	1.0345	85.78	14.22	5.07	3.66	4.76	0.73
" 16	1.0350	86.02	13.98	4.61	3.69	4.96	0.72	" 15	1.0340	86.06	13.94	4.89	3.72	4.62	0.71
" 18	1.0345	86.35	13.65	4.36	3.66	4.93	0.70	" 18	1.0340	86.72	13.28	4.08	3.75	4.71	0.74
" 21	1.0350	85.84	14.16	4.78	3.72	4.94	0.72	" 20	1.0340	86.42	13.58	4.27	3.63	4.94	0.74
" 23	1.0343	85.56	14.44	4.99	3.75	4.96	0.74	" 22	1.0350	86.16	13.84	4.74	3.78	4.57	0.75
" 25	1.0350	86.13	13.87	4.56	3.78	4.78	0.75	" 25	1.0335	85.63	14.37	5.18	3.66	4.83	0.70
" 28	1.0360	86.95	13.05	4.02	3.63	4.67	0.73	" 27	1.0350	86.39	13.61	4.53	3.63	4.73	0.72
" 30	1.0335	86.26	13.74	4.56	3.63	4.81	0.74	" 29	1.0348	85.24	14.76	5.57	3.84	4.62	0.73
Average	**1.0350**	**86.15**	**13.85**	**4.54**	**3.64**	**4.95**	**0.73**	**Average**	**1.0344**	**86.07**	**13.93**	**4.81**	**3.65**	**4.75**	**0.73**

RECORD OF ANALYSES OF MILK OF GUERNSEYS FOR SEPTEMBER AND OCTOBER, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
September 17	1.0355	86.02	13.98	4.52	3.84	4.84	0.78
" 19	1.0355	85.22	14.78	5.32	3.81	4.89	0.76
" 22	1.0358	85.33	14.67	5.02	4.09	4.78	0.78
" 24	1.0355	85.31	14.69	5.24	4.03	4.68	0.74
" 26.........	1.0348	84 40	15.60	6.00	4.22	4.63	0.75
" 29.........	1.0340	85.72	14.28	5.03	4.03	4'45	0.77
Average....................	**1.0352**	**85.33**	**14.67**	**5.22**	**4.00**	**4.71**	**0.76**

DATE.	Sl	W	T	PERCENTAGE OF Fat.	Casein and Albumen.	Sugar.	Ash.
October 1..	1.0360	84.84	15.16	5.60	4.13	4.64	0.79
" 3..	1.0355	85.11	14.89	5.30	4.16	4.64	0.79
" 6............	1.0348	84.88	15.12	5.75	4.03	4.55	0.79
" 8............	1.0345	84.53	15.47	5.86	4.00	4.82	0.79
" 10..	1.0345	84.77	15.23	5.82	4.00	4.61	0.80
" 13	1.0348	84.23	15.77	6.20	4.09	4.70	0.78
" 15.............	1.0340	84.22	15.78	6.20	4.03	4.75	0 80
" 17............	1.0350	84.65	15.35	5.85	4.00	4.71	0.79
" 20	1.0342	84.38	15.62	6.11	4.00	4.73	0.78
" 22.............	1.0350	84.31	15.69	6.09	3.81	4.99	0.80
" 24............	1.0348	84.81	15.19	5.62	3.88	4.90	0.79
" 27............	1.0340	84.22	15.78	6.49	3.84	4.66	0.79
" 29............	1.0350	85.81	14.19	4.90	3.81	4.71	0.77
" 31............	1.0342	85.34	14.66	5.18	3.97	4.74	0.77
Average.................	**1.0347**	**84.72**	**15.28**	**5.78**	**3.98**	**4.73**	**0.79**

RECORD OF ANALYSES OF MILK OF HOLSTEIN-FRIESIANS FOR MARCH AND APRIL, 1890.

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March 3	1.0320	87.60	12.40	3.79	3.19	4.94	0.48	April 2	1.0320	87.59	12.41	3.92	3.91	3.97	0.61
" 5	1.0330	87.26	12.74	4.12	2.63	5.40	0.59	" 4	1.0320	87.63	12.37	3.82	3.16	4.73	0.66
" 7	1.0330	87.29	12.71	4.10	3.06	4.90	0.65	" 7	1.0320	87.74	12.26	3.72	3.97	3.93	0.64
" 10	1.0320	87.55	12.45	3.99	2.97	4.87	0.62	" 9	1.0320	87.74	12.26	3.76	3.91	3.96	0.63
" 12	1.0320	87.63	12.37	3.84	2.59	5.34	0.60	" 11	1.0318	87.52	12.48	3.86	3.72	4.33	0.57
" 14	1.0325	87.78	12.22	3.71	3.13	4.72	0.66	" 14	1.0320	87.19	12.81	4.05	3.34	4.79	0.63
" 17	1.0325	87.42	12.58	4.10	3.13	4.75	0.60	" 16	1.0320	87.39	12.61	4.03	3.53	4.48	0.57
" 19	1.0330	87.75	12.25	3.83	2.91	4.91	0.60	" 18	1.0318	87.59	12.41	3.87	3.69	4.21	0.64
" 21	1.0340	87.32	12.68	3.91	3.09	5.10	0.58	" 21	1.0315	87.61	12.39	3.87	3.66	4.24	0.62
" 24	1.0320	87.90	12.10	3.65	3.16	4.70	0.59	" 23	1.0315	87.69	12.31	3.73	3.31	4.67	0.60
" 26	1.0320	87.52	12.48	3.85	3.78	4.21	0.64	" 25	1.0330	87.64	12.36	3.82	3.06	4.94	0.54
" 28	1.0325	87.50	12.50	3.83	3.19	4.86	0.62	" 28	1.0318	87.71	12.29	3.79	3.38	4.55	0.57
" 31	1.0325	87.50	12.50	3.88	3.41	4.63	0.58	" 30	1.0320	87.87	12.13	3.68	3.22	4.60	0.63
Average	**1.0325**	**87.54**	**12.46**	**3.89**	**3.10**	**4.87**	**0.60**	**Average**	**1.0320**	**87.61**	**12.39**	**3.84**	**3.53**	**4.41**	**0.61**

RECORD OF ANALYSES OF MILK OF HOLSTEIN-FRIESIANS FOR MAY AND JUNE, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
May 2	1.0320	87.52	12.48	3.79	3.84	4.29	0.56
" 5	1.0325	87.56	12.44	3.78	3.84	4.30	0.52
" 7	1.0325	87.81	12.19	3.57	3.75	4.30	0.57
" 9	1.0320	87.96	12.04	3.46	3.66	4.32	0.60
" 12	1.0320	87.79	12.21	3.48	3.84	4.27	0.62
" 14	1.0327	87.37	12.63	3.66	3.69	4.70	0.58
" 16	1.0330	87.50	12.50	3.53	3.66	4.73	0.58
" 19	1.0320	87.36	12.64	3.68	3.84	4.51	0.61
" 21	1.0325	87.06	12.94	3.78	3.94	4.60	0.62
" 23	1.0335	87.97	12.03	3.76	3.59	5 08	0.60
" 26	1.0345	87.15	12.85	3.63	3.47	5.11	0.64
" 28	1.0330	87.09	12.91	3.73	3.47	5.10	0.61
Average	**1.0327**	**87.43**	**12.57**	**3.65**	**3.72**	**4.61**	**0.59**

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
June 2.	1.0340	86.78	13.22	3.53	3.47	5.58	0.64
" 4.	1.0350	86.06	13.94	4.30	3.47	5.51	0.66
" 6.	1.0340	87.30	12.70	3.71	3.38	4.98	0.63
" 9.	1.0365	86.20	13.80	4.23	3.53	5.32	0.72
" 11.	1.0363	86.83	13.17	3.75	3.63	5.13	0.66
" 13.	1.0360	86.03	13.97	4.26	3.53	5.52	0.66
" 16.	1.0355	86.29	13.71	4.09	3.59	5.35	0.68
" 23.	1.0350	87.55	12.45	3.55	3.03	5.13	0.74
" 25.	1.0350	87.89	12.11	[illegible]	3.06	5.14	0.71
" 27.	1.0340	88.23	11.77	3.10	3.13	4.88	0.66
" 30.	1.0345	87.94	12.06	3.31	3.09	4.99	0.67
Average	**1.0351**	**87.01**	**12.99**	**3.73**	**3.36**	**5.33**	**0.67**

RECORD OF ANALYSES OF MILK OF HOLSTEIN-FRIESIANS FOR JULY AND AUGUST, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
July 2	1.0330	88.14	11.86	3.27	3.28	4.70	0.61
" 7	1.0335	88.40	11.60	3.23	3.06	4.64	0.67
" 11	1.0315	88.20	11.80	3.33	3.25	4.57	0.65
" 14	1.0330	88.17	11.73	3.38	3.31	4.39	0.65
" 16	1.0320	88.90	11.10	2.71	3.16	4.58	0.65
" 18	1.0320	88.74	11.26	2.94	2.94	4.74	0.64
" 21	1.0325	88.64	11.36	3.08	3.06	4.57	0.65
" 23	1.0320	88.65	11.35	3 06	2.90	4.74	0.65
" 25	1.0320	88.75	11.25	2.96	3.25	4.38	0.66
" 28	1.0325	88.77	11.23	3.05	3.22	4.30	0.66
" 30	1.0315	88.65	11.34	3.27	3.19	4.23	0.65
Average	**1.0323**	**88.56**	**11.44**	**3.11**	**3.15**	**4.53**	**0.65**

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
August 1	1.0310	88.90	11.10	3.14	3.16	4.14	0.66
" 4	1.0330	88.64	11.36	3.17	3.19	4.33	0.67
" 6	1.0330	88.84	11.16	2.96	3.03	4.50	0.67
" 8	1.0320	88.85	11.15	2.88	3.00	4.62	0.65
" 11	1.0325	88 80	11.20	2.99	3.13	4.40	0.68
" 13	1.0315	89.08	10.92	2.68	3.06	4.55	0.63
" 15	1.0320	88.54	11.46	3.13	3.03	4.67	0.63
" 18	1.0315	88.48	11.52	3.30	3.06	4.49	0.67
" 20	1.0315	88.84	11.16	2.92	2.94	4.68	0.62
" 22	1.0330	88.45	11.55	3.31	3.03	4.63	0.58
" 25	1.0320	88.55	11.45	3.07	2.94	4.81	0.63
" 27	1.0335	88.54	11.46	3.11	2.84	4.88	0.63
" 29	1.0330	88.50	11.50	2.96	2.88	5.00	0.66
Average	**1.0323**	**88.62**	**11.38**	**3.05**	**3.10**	**4.59**	**0.64**

RECORD OF ANALYSES OF MILK OF HOLSTEIN-FRIESIANS FOR SEPTEMBER AND OCTOBER, 1890.

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
September 17	1.0330	88.40	11.60	3.16	2.91	4.85	0.68
" 19	1.0335	88.27	11.73	3.18	3.16	4.69	0.70
" 22	1.0330	88.25	11.75	3.32	2.97	4.76	0.70
" 24	1.0325	88.38	11.62	3.14	3.06	4.73	0.69
" 26	1.0325	88.18	11.82	3.36	3.09	4.71	0.66
" 29	1.0320	88.52	11.48	3.21	3.03	4.59	0.65
Average	**1.0327**	**88.33**	**11.67**	**3.23**	**3.04**	**4.72**	**0.68**

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
October 1	1.0325	88.20	11.80	3.30	3.13	4.64	0.73
" 3	1.0335	88.06	11.94	3.31	3.28	4.65	0.70
" 6	1.0315	88.56	11.44	3.46	2.91	4.38	0.69
" 8	1.0328	87.67	12.33	3.57	3.47	4.59	0.70
" 10	1.0330	87.83	12.17	3.54	3.14	4.77	0.72
" 13	1.0332	87.69	12.31	3.67	3.28	4.63	0.73
" 15	1.0325	87.75	12.25	3.55	3.47	4.53	0.70
" 17	1.0335	87.83	12.17	3.61	3.22	4.68	0.66
" 20	1.0325	87.84	12.16	3.62	3.28	4.55	0.71
" 22	1.0325	87.56	12.44	3.78	3.16	4.78	0.72
" 24	1.0325	87.88	12.12	3.57	3.25	4.59	0.71
" 27	1.0325	88.03	11.97	3.64	3.19	4.42	0.72
" 29	1.0320	87.90	12.10	3.58	3.22	4.59	0.71
" 31	1.0323	88.06	11.94	3.48	3.19	4.58	0.69
Average	**1.0326**	**87.92**	**12.08**	**3.55**	**3.23**	**4.60**	**0.71**

RECORD OF ANALYSES OF MILK OF JERSEYS FOR MARCH AND APRIL, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March 3	1.0345	85.07	14.93	5.47	3.94	4.82	0.70	April 2	1.0355	84.53	15.47	5.61	5.41	3.62	0.83
" 5	1.0360	85.20	14.80	5.30	3.81	4.82	0.87	" 4	1.0345	85.27	14.73	5.31	4.38	4.25	0.79
" 7	1.0350	84.86	15.14	5.48	4.13	4.74	0.79	" 7	1.0358	84.77	15.23	5.58	4.34	4.73	0.78
" 10	1.0350	85.10	14.90	5.42	4.16	4.43	0.89	" 9	1.0345	85.21	14.79	5.26	4.41	4.34	0.78
" 12	1.0362	84.98	15.02	5.24	3.69	5.23	0.86	" 11	1.0350	84.90	15.10	5.47	4.00	4.83	0.80
" 14	1.0360	84.80	15.20	5.62	4.22	4.55	0.81	" 14	1.0345	85.36	14.64	5.23	4.09	4.56	0.76
" 17	1.0355	85.12	14.88	5.86	4.19	4.50	0.83	" 16	1.0348	84.67	15.33	5.69	4.47	4.39	0.78
" 19	1.0355	85.36	14.64	5.09	3.97	4.79	0.79	" 18	1.0340	85.46	14.54	5.07	4.56	4.13	0.78
" 21	1.0368	84.80	15.20	5.52	4.22	4.67	0.79	" 21	1.0338	85.28	14.72	5.36	4.40	4.18	0.78
" 24	1.0350	84.79	15.21	5.27	4.59	4.54	0.81	" 23	1.0340	85.52	14.48	5.16	3.94	4.60	0.78
" 26	1.0350	85.28	14.72	5.22	4.84	3.86	0.80	" 25	1.0340	85.29	14.71	5.27	3.94	4.72	0.78
" 28	1.0350	84.75	15.25	5.40	4.53	4.48	0.84	" 28	1.0350	85.17	14.83	5.24	4.25	4.62	0.72
" 31	1.0355	85.05	14.95	5.33	4.44	4.36	0.82	" 30	1.0338	85.75	14.25	5.03	4.22	4.23	0.77
Average	**1.0354**	**85.01**	**14.99**	**5.36**	**4.21**	**4.60**	**0.82**	**Average**	**1.0340**	**85.17**	**14.83**	**5.32**	**4.33**	**4.40**	**0.78**

RECORD OF ANALYSES OF MILK OF JERSEYS FOR MAY AND JUNE, 1890.

Date.	Specific Gravity.	Percentage of Water.	Percentage of Total Solids.	Percentage of Fat.	Percentage of Casein and Albumen.	Percentage of Sugar.	Percentage of Ash.	Date.	Specific Gravity.	Percentage of Water.	Percentage of Total Solids.	Percentage of Fat.	Percentage of Casein and Albumen.	Percentage of Sugar.	Percentage of Ash.
May 2	1.0348	85.91	14.09	4.55	4.03	4.79	0.72	June 2.	1.0345	86.42	13.58	4.19	3.16	5.53	0.70
" 5	1.0335	85.64	14.36	4.94	3.97	4.68	0.77	" 4.	1.0358	86.45	13.55	3.89	3.63	5.25	0.78
" 7	1.0340	85.98	14.02	4.57	4.31	4.41	0.73	" 6.	1.0355	86.90	13.10	4.05	3.09	5.23	0.73
" 9	1.0340	86.69	13.31	3.98	4.37	4.24	0.72	" 9.	1.0360	86.95	13.05	3.93	2.84	5.54	0.74
" 12	1.0340	86.96	13.04	3.83	4.25	4.24	0.72	" 11.	1.0360	86.52	13.48	4.22	3.22	5.32	0.72
" 14	1.0345	86.22	13.78	4.39	4.22	4.44	0.73	" 13.	1.0368	86.35	13.65	4.21	3.13	5.57	0.74
" 16	1.0345	85.92	14.08	4.70	4.22	4.44	0.72	" 16.	1.0355	86.59	13.41	4.07	3.16	5.45	0.73
" 19	1.0340	86.86	13.14	3.83	4.53	4.07	0.71	" 20.	1.0365	86.98	13.02	3.77	3.16	5.39	0.70
" 21	1.0342	86.11	13.89	4.54	4.38	4.30	0.67	" 23.	1.0365	86.35	13.65	4.21	3.41	5.31	0.72
" 23	1.0345	86.24	13.76	4.28	4.25	4.53	0.70	" 25.	1.0365	86.15	13.85	4.34	3.28	5.49	0.74
" 26	1.0350	86.66	13.34	4.03	3.94	4.64	0.73	" 27.	1.0355	86.33	13.67	4.23	3.53	5.21	0.70
" 28	1.0342	86.72	13.28	3.93	3 44	5.16	0.75	" 30.	1.0360	86.99	13.01	3.86	3.47	5.02	0.66
Average	**1.0343**	**86.33**	**13.67**	**4.30**	**4.16**	**4.49**	**0.72**	**Average**	**1.0359**	**86.58**	**13.42**	**4.08**	**3.26**	**5.36**	**0.72**

RECORD OF ANALYSES OF MILK OF JERSEYS FOR JULY AND AUGUST, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
July 2	1.0350	86.81	13.19	3.85	3.66	4.96	0.72	August 1	1.0350	86.59	13.41	4.11	3.63	4.93	0.74
" 7	1.0358	86.61	13.39	4.06	3.59	4.99	0.75	" 4	1.0350	86.49	13.51	4.49	3.63	4.61	0.78
" 9	1.0365	86.82	13.18	3.82	3.47	5.19	0.70	" 6	1.0345	87.00	13.00	4.26	3.53	4.47	0.74
" 11	1.0348	86.61	13.39	4.20	3.34	5.19	0.66	" 8	1.0345	86.89	13.11	3.97	3.53	4.91	0.70
" 14	1.0355	86.58	13.42	4.09	3.59	5.05	0.69	" 11	1.0353	86.48	13.52	4.10	3.72	4.96	0.74
" 16	1.0345	86.73	13.27	3.99	3.75	4.79	0.74	" 13	1.0345	86.80	13.20	3.72	3.75	5.01	0.72
" 18	1.0350	86.53	13.47	4.20	3.66	4.92	0.69	" 15	1.0350	86.68	13.32	3.82	3.84	5.02	0.64
" 21	1.0355	86.38	13.62	4.16	3.69	5.04	0.73	" 18	1.0340	86.60	13.40	4.03	3.72	4.95	0.70
" 23	1.0348	86.19	13.81	4.48	3.72	4.88	0.73	" 20	1.0350	86.08	13.92	4.38	3.78	5.08	0.68
" 25	1.0355	86.28	13.72	4.39	3.84	4.79	0.70	" 22	1.0360	86.08	13.92	4.26	3.84	5.12	0.70
" 28	1.0358	86.51	13.49	4.16	3.81	4.78	0.74	" 25	1.0350	85.98	14.02	4.48	3.72	5.14	0.68
" 30	1.0340	86.49	13.51	4.13	3.69	4.94	0.75	" 27	1.0355	85.98	14.02	4.42	3.75	5.14	0.71
								" 29	1.0348	85.54	14.46	4.82	3.81	5.13	0.70
Average	**1.0352**	**86.54**	**13.46**	**4.13**	**3.65**	**4.96**	**0.72**	**Average**	**1.0353**	**86.40**	**13.60**	**4.22**	**3.71**	**4.96**	**0.71**

RECORD OF ANALYSES OF MILK OF JERSEYS FOR SEPTEMBER AND OCTOBER, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
September 17	1.0370	85.17	14.83	4.79	3.81	5.45	0 78
" 19	1.0365	84.17	15.83	5.74	4.03	5.32	0.74
" 22	1.0335	85.96	14.04	4.99	3.84	4.52	0.69
24	1.0375	85.02	14.98	4.71	4.13	5.39	0.75
" 26	1.0370	84.94	15.06	5.03	4.28	4.99	0.76
" 29	1.0375	84.77	15.23	5.24	4.16	5.07	0.76
Average	**1.0365**	**85.00**	**15.00**	**5.08**	**4.04**	**5.13**	**0.75**

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
October 1	1.0365	85.00	15.00	4.95	4.28	4.93	0.84
" 3	1.0375	83.97	16.03	5.71	4.16	5.36	0.80
" 6	1.0320	86.45	13.55	4.74	3.81	4.28	0.72
" 8	1.0363	83.42	16.58	6.04	4.47	5.28	0.79
" 10	1.0370	83.75	16.25	6.13	4.28	5.03	0.81
" 13	1.0365	83.54	16.46	6.39	4.31	4.96	0.80
" 15	1.0360	84.10	15.90	5.82	4.38	4.91	0.79
" 17	1.0360	84.67	15.33	5.42	4.41	4.72	0.78
" 20	1.0370	83.93	16.07	5.90	4.34	5.03	0.80
" 24	1.0355	84.58	15.42	5.44	4.47	4.70	0.81
" 27	1.0360	83.99	16.01	5.90	4.44	4.86	0.81
" 29	1.0358	83.96	16.04	5.91	4.44	4.88	0.81
" 31	1.0355	83.87	16.13	5.90	4.59	4.85	0.79
Average	**1.0355**	**84.25**	**15.75**	**5.71**	**4.34**	**4.91**	**0.80**

RECORD OF ANALYSES OF MILK OF SHORT-HORNS FOR MARCH AND APRIL, 1890.

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March 3	1.0350	86.45	13.55	4.23	3.91	4.73	0.68
" 5	1.0345	85.87	14.13	5.23	3.94	4.13	0.83
" 7	1.0352	86.30	13.70	4.24	3.59	5.04	0.83
" 10	1.0350	86.78	13.22	3.98	4.16	4.34	0.74
" 12	1.0340	85.69	14.31	5.05	3.31	5.14	0.81
" 14	1.0355	86.78	13.22	4.16	3.94	4.26	0.86
" 17	1.0330	85.64	14.36	5.47	3.94	5.13	0.82
" 19	1.0340	86.00	14.00	4.95	4.00	4.20	0.85
" 21	1.0345	85.67	14.33	5.15	3.94	4.42	0.82
" 24	1.0340	86.28	13.72	4.40	4.34	4.12	0.86
" 26	1.0335	84.85	15.15	6.02	4.84	3.48	0.81
" 28	1.0350	85.77	14.23	4.39	4.91	4.07	0.86
Average	**1.0341**	**86.01**	**13.99**	**4.69**	**4.07**	**4.42**	**0.81**

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
April 14	1.0343	86.67	13.33	4.25	3.66	4.68	0.74
" 16	1.0343	86.72	13.28	4.13	3.53	4.83	0.79
" 18	1.0343	87.33	12.67	3.67	3.28	4.99	0.73
" 21	1.0330	87.33	12.67	3.80	3.34	4.81	0.72
" 23	1.0332	87.52	12.48	3.76	3.06	4.92	0.74
" 25	1.0335	87.51	12.49	3.80	3.72	4.26	0.71
" 28	1.0335	87.14	12.86	4.09	3.41	4.64	0.72
" 30	1.0335	87 70	12.30	3.62	3.47	4.50	0.71
Average	**1.0337**	**87.24**	**12.76**	**3.89**	**3.41**	**4.73**	**0.73**

RECORD OF ANALYSES OF MILK OF SHORT-HORNS FOR MAY AND JUNE, 1890.

Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.	Date.	Specific Gravity.	Percentage of Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
May 2	1.0335	87.49	12.51	3.36	3.41	5.01	0.73	June 2	1.0340	88.06	11.94	3.10	2.59	5.56	0.69
" 5	1.0335	87.70	12.30	3.54	3.41	4.66	0.69	" 4	1.0345	87.97	12.03	3.38	2.47	5.45	0.73
" 7	1.0335	88.22	11.78	3.08	3.47	4.51	0.72	" 6	1.0335	87.95	12.05	3.75	2.38	5.22	0.70
" 9	1.0332	87.93	12.07	3.33	3.34	4.67	0.73	" 9	1.0345	88.24	11.76	3.16	2.41	5.48	0.71
" 12	1.0335	87.86	12.14	3.17	3.47	4.77	0.73	" 11	1.0355	88.21	11.79	3.02	2.59	5.44	0.74
" 14	1.0338	87.94	12.06	3.31	3.81	4.19	0.75	" 13	1.0353	88.03	11.97	3.14	2.53	5.59	0.71
" 16	1.0340	87.60	12.43	3.52	3.38	4.82	0.71	" 16	1.0345	87.74	12.26	3.32	2.56	5.66	0.72
" 19	1.0335	88.01	11.99	3.18	3.78	4.31	0.72	" 20	1.0350	87.89	12.11	3.40	2.63	5.39	0.69
" 21	1.0340	88.00	12.00	3.10	3.84	4.37	0.69	" 23	1.0345	87.97	12.03	3.25	2.97	5.09	0.72
" 23	1.0340	88.20	11.80	2.96	3.66	4.47	0.71	" 25	1.0355	87.86	12.14	3.28	2.75	5.36	0.75
" 26	1.0345	88.35	11.65	3.16	3.59	4.22	0.68	" 27	1.0345	88.23	11.77	3.01	2.97	5.13	0.66
" 28	1.0330	88.19	11.81	3.14	2.84	5.12	0.71	" 30	1.0350	88.26	11.74	2.94	2.84	5.23	0.73
Average	**1.0337**	**87.95**	**12.05**	**3.24**	**3.50**	**4.59**	**0.72**	**Average**	**1.0347**	**88.03**	**11.97**	**3.23**	**2.64**	**5.38**	**0.71**

RECORD OF ANALYSES OF MILK OF SHORT-HORNS FOR JULY AND AUGUST, 1890.

DATE.	Specific Gravity.	Percentage of Water.	Percentage of Total Solids.	Percentage of Fat.	Percentage of Casein and Albumen.	Percentage of Sugar.	Percentage of Ash.
July 2	1.0338	87.74	12.26	3.67	3.03	4.85	0.71
" 7	1.0350	88.23	11.77	3.12	2.81	5.11	0.73
" 9	1.0358	88.26	11.74	2.89	2.94	5.19	0.72
" 11	1.0330	87.59	12.41	3.80	3.03	4.88	0.70
" 14	1.0340	88.30	11.70	3.10	3.06	4.82	0.72
" 16	1.0335	88.47	11.53	2.90	3.25	4.64	0.74
" 18	1.0330	88.18	11.82	3.36	2.94	4.82	0.70
" 21	1.0345	88.10	11.90	3.22	2.97	5.01	0.70
" 23	1.0328	87.82	12.18	3.55	3.06	4.84	0.73
" 25	1.0335	87.93	12.07	3.62	3.09	4.64	0.72
" 28	1.0335	88 02	11.98	3.33	3.03	4.93	0.69
" 30	1.0335	88.65	11.35	2.76	2.91	4.95	0 73
Average	**1.0338**	**88.11**	**11.89**	**3.38**	**3.01**	**4.89**	**0.71**

DATE.	Specific Gravity.	Percentage of Water.	Percentage of Total Solids.	Percentage of Fat.	Percentage of Casein and Albumen.	Percentage of Sugar.	Percentage of Ash.
August 1	1.0320	88.37	11.63	3.29	2.94	4.70	0.70
" 4	1.0340	88.28	11.72	3.33	2.88	4.78	0.73
" 6	1.0330	88.20	11.80	3.57	2.95	4.59	0.69
" 8	1.0325	87.48	12.52	4.05	3.06	4.70	0.71
" 11	1.0335	88.00	12.00	3.42	3.03	4.82	0.73
" 13	1.0320	88.43	11.57	3.17	3.13	4.60	0.67
" 15	1.0335	87.80	12.20	3.75	3.13	4.62	0.70
" 18	1.0320	88.18	11.82	3.26	3.03	4.81	0.72
" 20	1.0328	87.78	12.22	3.46	3.03	5.01	0.72
" 22	1.0340	87.56	12.44	4.02	3.06	4.68	0.68
" 25	1.0330	87.34	12.66	4.01	3.13	4.83	0.69
" 27	1.0345	88.04	11.96	3.27	3.06	4.90	0.73
" 29	1.0330	87.57	12.43	3.66	3.13	4.92	0.72
Average	**1.0333**	**87.92**	**12.08**	**3.56**	**3.04**	**4.77**	**0.71**

RECORD OF ANALYSES OF MILK OF SHORT-HORNS FOR SEPTEMBER AND OCTOBER, 1890.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
September 17	1.0345	87.85	12.15	3.42	3.03	4.99	0.71
" 19	1.0340	87.71	12.29	3.45	3.25	4.85	0.74
" 22	1.0340	87.82	12.18	3.37	3.13	4.94	0.74
" 24	1.0340	87.81	12.19	3.30	3.22	4.96	0.71
" 26	1.0345	57.51	12.49	3.85	3.31	4.60	0.73
" 29	1.0335	87.87	12.13	3.43	3.16	4.84	0.70
Average	**1.0341**	**87.76**	**12.24**	**3.47**	**3.18**	**4.86**	**0.72**

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
October 1	1.0335	87.83	12.17	3.58	3.19	4.65	0.75
" 3	1.0350	87.39	12.61	3.85	3.44	4.56	0.76
" 6	1.0335	87.35	12.65	3.94	3.25	4.69	0.77
" 8	1.0340	87.06	12.94	3.88	3.53	4.77	0.76
" 10	1.0335	87.56	12.44	3.61	3.25	4.84	0.74
" 13	1.0340	87.34	12.66	3.74	3.38	4.78	0.76
" 15	1.0330	87.91	12.09	4.29	3.38	4.70	0.72
" 17	1.0340	87.51	12.49	3.67	3.28	4.82	0.72
" 20	1.0340	87.16	12.84	4.05	3.38	4.69	0.72
" 22	1.0330	87.53	12.47	3.73	3.19	4.81	0.74
" 24	1.0330	87.60	12.40	3.64	3.19	4.84	0.73
" 29	1.0335	87.66	12.34	3.62	3.09	4.89	0.74
" 31	1.0330	87.18	12.82	4.02	3.28	4.77	0.75
Average	**1.0336**	**87.39**	**12.61**	**3.82**	**3.28**	**4.76**	**0.75**

RECORD OF AVERAGE ANALYSES OF MILK OF HERDS.

AYRSHIRES.

			Percentage of				
			Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March	1.0341	87.00	13.00	3.95	3.44	4.93	0.68
April	1.0342	86.91	13.09	3.85	3.80	4.72	0.72
May	1.0346	87.03	12.97	3.54	3.81	4.86	0.76
June	1.0352	87.42	12.52	3.42	3.28	5.20	0.68
July	1.0337	87.28	12.72	3.71	3.56	4.79	0.66
August	1.0335	86.92	13.08	4.07	3.63	4.68	0.67
September	1.0336	88.15	11.85	3.26	3.11	4.79	0.68
October	1.0341	87.73	12.27	3.60	3.24	4.74	0.70
Average for 8 Months	**1.0341**	**87.30**	**12.70**	**3.68**	**3.48**	**4.84**	**0.69**

GUERNSEYS.

Date.	Specific Gravity.	Percentage of					
		Water.	Total Solids.	F	C A	Sugar.	Ash.
March	1.0357	84.71	15.29	5.46	4.27	4.80	0.76
April	1.0351	85.05	14.95	5.20	4.37	4.62	0.76
May	1.0344	86.00	14.00	4.57	4.14	4.57	0.72
June	1.0353	86.14	13.86	4.55	3.27	5.32	0.73
July	1.0350	86.15	13.85	4.54	3.64	4.95	0.73
August	1.0344	86.07	13.93	4.81	3.65	4.75	0.73
September	1.0352	85.33	14.67	5.22	4.00	4.71	0.76
October	1.0347	84.72	15.28	5.78	3.98	4.73	0.79
Average for 8 Months	**1.0350**	**85.53**	**14.48**	**5.02**	**3.92**	**4.80**	**0.75**

HOLSTEIN-FRIESIANS.

March	1.0325	87.54	12.46	3 89	3.10	4.87	0.60
April	1.0320	87.61	12.39	3.84	3.53	4.41	0.61
May	1.0327	87.43	12.57	3.65	3.72	4.61	0.59
June	1.0351	87.01	12.99	3.73	3.36	5.23	0.67
July	1.0323	88.56	11.44	3.11	3.15	4.53	0.65
August	1.0323	88.62	11.38	3.05	3.10	4.59	0.64
September	1.0327	88.33	11.67	3.23	3.04	4.72	0.68
October	1.0326	87.92	12.08	3.55	3.23	4.60	0.71
Average for 8 Months	**1.0328**	**87.88**	**12.12**	**3.51**	**3.28**	**4.69**	**0.64**

JERSEYS.

March	1.0354	85.01	14.99	5.36	4.21	4.60	0.82
April	1.0340	85.17	14.83	5.32	4.33	4.40	0.78
May	1.0343	86.33	13.67	4.30	4.16	4.49	0.72
June	1.0359	86.58	13.42	4.08	3.26	5.36	0.72
July	1.0352	86.54	13.46	4.13	3.65	4.96	0.72
August	1.0353	86.60	13.60	4.22	3.71	4.96	0.71
September	1.0365	85.00	15.00	5.08	4.04	5.13	0.75
October	1.0355	84.25	15.75	5.71	4.34	4.91	0.80
Average for 8 Months	**1.0353**	**85.60**	**14.34**	**4.78**	**3.96**	**4.85**	**0.75**

Record of Average Analyses of Milk of Herds.

SHORT-HORNS.

DATE.	Specific Gravity.	PERCENTAGE OF Water.	Total Solids.	Fat.	Casein and Albumen.	Sugar.	Ash.
March	1.0341	86.01	13.99	4.69	4.07	4.42	0.81
April	1.0337	87.24	12.76	3.89	3.41	4.73	0.73
May	1.0337	87.95	12.05	3.24	3.50	4.59	0.72
June	1.0347	88.03	11.97	3.23	2.64	5.38	0.71
July	1.0338	88.11	11.89	3.28	3.01	4.89	0.71
August	1.0333	87.92	12.08	3.56	3.04	4.77	0.71
September	1.0341	87.76	12.24	3.47	3.18	4.86	0.72
October	1.0336	87.39	12.61	3.82	3.28	4.76	0.75
Average for 8 Months	**1.0339**	**87.55**	**12.45**	**3.65**	**3.27**	**4.80**	**0.73**

The amount and proportion of the food compounds furnished the herds in the daily rations since December, 1889, remained practically constant. The green food and pasture during the summer months were fed in such quantities as to substitute the coarse materials fed during the remainder of the year.

As noted previously, complete chemical analysis of the milk was made every other day. The changes in the composition of the milk for short periods were not noticeable when equal conditions were maintained.

The total solids in the milk of all the breeds was lowest during the summer months; a gradual decrease in quality was noticed from April to June and an increase from September, though the actual food compounds eaten were as uniform as possible and the period of greatest milk flow did not occur for all the animals during the months of June to September, inclusive. It would seem, therefore, that summer conditions of feed and weather, which as a rule favorably influenced milk flow, did so at the expense of quality.

The specific gravity of the milk of each sample is also entered in the tables. This was determined in every case by both the lactometer and the Westphal balance, the results of each agreeing closely. A study of this work shows that the lactometer when properly handled

does indicate the specific gravity, but that the specific gravity is not a safe guide as to the quality of the milk. With the exception of the Holsteins, the average percentage of solids in the milk produced by the herds in June was much lower than the average for eight months, while the specific gravity of the June milk was much higher than the average specific gravity for the eight months. In the case of the Ayrshires' and Short-Horns' milk, the specific gravity was *higher in June* than in *any other* month, though the actual quality of the milk was much lower than in March, April, May, July and August for the Ayrshires, and every month except July for the Short-Horns. The analyses show also that in the month of June there was a decided change in the relative amounts of the casein and sugar in the milk of all the breeds, viz., a decrease in the per cent. of casein, and an increase in the sugar. That this change in the relation of these compounds influenced the specific gravity of the milk is undoubted, though the exact cause of the change in composition of the milk in this month must be determined by further study.

TABLE 1.

Average Composition of Milk for Eight Months.

HERD.	Specific Gravity.	PERCENTAGE OF					
		Water.	Total Solids.	Fat.	Casein.	Sugar.	Ash.
Ayrshire	1.0341	87.30	12.70	3.68	3.48	4.84	0.69
Guernsey	1.0350	85.52	14.48	5.02	3.92	4.80	0.75
Holstein-Friesian	1.0328	87.88	12.12	3.51	3.28	4.69	0.64
Jersey	1.0353	85.66	14.34	4.78	3.96	4.85	0.75
Short-Horn	1.0339	87.55	12.45	3.65	3.27	4.80	0.73

Table 1 shows the average composition of the milk of the different breeds for eight months. A hasty examination would seem to prove that a difference in the amount of total solids in the milk of the different breeds was accompanied by a corresponding variation in all the compounds contained in them except sugar, and that sugar remained practically constant for all the breeds.

A study of the percentage composition of the total solids, as given in Table 2, shows, however, that the casein is the practically constant factor in all, and that fat, sugar and ash differ in such a way as to form two distinct and uniform products, one including the milk of the Jerseys and Guernseys, the total solids of which contain an average of 34 per cent. fat, 27.3 per cent. casein, 33.5 per cent. sugar and 5.2 per cent. ash; the other including the milk of the Holsteins, Ayrshires and Short-Horns, the total solids of which contain an average of 29.2 per cent. fat, 27 per cent. casein, 38.5 per cent. sugar and 5.5 per cent. ash. The relative value of these products, either as actual food compounds or for the different purposes of the dairy, and their comparative cost, either from the distinct breeds furnishing the same product or from the two classes of breeds indicated, can unfortunately only be partially shown by the data secured in this study up to October 31st.

TABLE 2.

Average Composition of Total Solids in the Milk of the Different Breeds.

HERD.	POUNDS PER HUNDRED OF			
	Fat.	Casein.	Sugar.	Ash.
Ayrshire	29.1	27.4	38.1	5.4
Guernsey	34.7	27.1	33.3	5.2
Holstein-Friesian	29.1	27.1	38.7	5.3
Jersey	33.3	27.6	33.8	5.2
Short-Horn	29.3	26.3	38.6	5.8

In Table 3 the total amount of food eaten, its cost and the milk produced by the different herds from May 1st, 1889, to October 31st, 1890, are tabulated.

The number of days under experiment for each herd includes only the time when the animals, since their arrival at the farm, were considered to be proper subjects for experiment. All unequal conditions were as far as possible eliminated. The difference between days milking and days under experiment is the time that the cows of the

TABLE 3.—Amount of Food Consumed, its Cost, and Milk Produced, by Different Herds from May 1st, 1889, to October 31st, 1890.

Registered Name.	Total Number of Days Under Experiment.	No. of Days Milking.	Total Yield of Milk in Pounds.	Total Amount of Food Consumed. Hay.	Wheat Bran.	Corn and Oat Meal.	Cotton-Seed Meal.	Linseed Meal.	Dried Brewers' Grains.	Corn Stalks.	Green Fodder.	Ensilage, Corn.	Roots.	Pasture.	Total Cost of Food.
				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	hours.	
Miss Cornelia 2d	352	270	6,255.0	2,581	1,917	1,087	66	....	93	405	5,770	890	254	155	$53 81
Miss Cornelia 3d	150	150	2,964.9	350	561½	423½	....	....	413½	....	5,145	....	....	256	22 92
Hattie Pearl	526	475	13,122.3	2,995	1,979	2,262½	279	*211	320	403	11,575	800	449	201	84 72
Young Duchess	482	464	7,502.8	2,531	1,333	1,677½	210	†48	493	338	10,770	480	....	201	65 76
Herd of Ayrshires	1,510	1,359	29,845.0	8,457	5,790½	5,400½	555	259	1,819½	1,146	33,260	1,670	703	813	$226 71
Dairymaid 3d	170	170	4,437.3	321	1,075	121½	....	....	....	....	5,950	....	....	155	$20 96
Cherry du Laurier 4th	319	277	5,165.6	1,723	909	962	56	46	511	390	4,695	400	445	56	42 03
Ada	550	550	10,264.1	3,240	2,292	1,728	263	41	378	405	11,380	375	394	201	80 37
Dolly Ford	520	520	9,918.3	2,985	2,340	2,241	279	45	791	405	11,660	505	457	201	89 27
Herd of Guernseys	1,559	1,517	29,785.3	8,269	6,616	5,052½	598	132	1,680	1,200	33,685	1,280	1,296	618	$232 68
Jewel 3d	257	196	3,824.4	3,048	1,522	941	44	....	93	340	3,120	390	254	145	$47 38
Evadne	423	393	11,152.3	3,917	2,411	1,560	159	....	827	405	8,250	555	274	140	80 32
Benola Fletcher	365	280	10,388.8	3,658	2,153	1,524	230	45	365	405	7,250	275	954	56	74 42
Herd of Holstein-Friesians	1,045	869	25,365.5	10,623	6,086	4,025	433	45	1,285	1,150	18,620	1,220	1,482	341	$202 12
	549	513	12,234.9	3,065	2,514½	2,055½	136	5	677	415	12,270	455	417	201	$86 51
	433	334	6,274.7	2,784	2,134½	1,825½	160	....	88	405	8,045	510	254	155	63 41
	269	269	4,575.1	2,665	1,447	1,367	278	47	98	405	1,655	510	449	140	52 07
Herd of Jerseys	1,251	1,116	23,084.7	8,514	6,096	4,748	569	52	863	1,225	21,970	1,475	1,120	496	$201 99
	506	397	8,954.0	3,087	1,881	2,186½	192	....	294	405	10,318	510	254	201	$76 81
	549	473	11,588.4	3,089	2,370½	1,989½	98	....	646½	405	12,570	510	254	201	83 65
	549	454	10,827.6	3,078	2,432½	2,152	62	4	888½	405	12,540	345	424	201	87 80
Herd of Short-Horns	1,604	1,324	31,370.0	9,254	6,684	6,328	352	4	1,779	1,215	35,428	1,365	932	603	$247 76

*This includes 114 lbs. gluten meal and 70 lbs. oil meal. † This includes 30 lbs. gluten meal and 10 lbs. oil meal.

different herds were dry for the periods indicated. On this basis the Guernseys were dry for the shortest period; the Ayshires and Jerseys would each average about one month, and the Holstein-Friesians and Short-Horns about two months per year. There are conditions of dairy farming when this point would be of considerable importance in the selection of animals.

The cost of food consumed was secured from the prices actually paid for concentrated feeding-stuffs and by fixing market values on produce raised on the farm, and is uniform throughout for all the breeds. The prices used were as follows: Hay, $10.00 per ton; Wheat Bran, $17.60; Corn and Oat Meal, $20.40; Cotton-Seed Meal, $25.40; Linseed Meal, $29.40; Gluten Meal, $22.50; Oil Meal, $25.00; Dried Brewers' Grains, $16.60; Corn Stalks, $6.00; Green Fodder, $2.50; Ensilage Corn, $3.50; Roots, $8.00 per ton; and pasture, 10 cents per day of twelve hours.

The average solids and fat in the milk of the different breeds for eleven months is derived from the monthly averages in Table 4, and was used in securing the data for the condensed statements in Tables 5, 6 and 7.

In order that all the breeds may under the circumstances of this experiment be put upon as equal a basis as possible, it is assumed that the individual animals do represent their respective breeds, and that the average daily results secured from the herds of animals selected as representatives of their breeds, are relatively the same as might be expected from a representative animal of each; and therefore the average daily results as tabulated may be considered as the product of *one animal* for the time in the period given, which includes all the conditions that would occur throughout a year of milk flow, period dry, etc. The statements of the cost of food and amount of milk produced include, therefore, the whole number of days under experiment. In converting pounds into quarts the customary factor, 2.2, was used. All conditions, except cost of food and product secured, are assumed to be equal, hence Tables 5, 6 and 7 were prepared to show the comparative cost of food for each breed from three standpoints:

1. A quart of milk.
2. A pound of total solids.
3. A pound of butter fat.

TABLE 4.—Average Percentage of Total Solids, Fat and Solids not Fat, in the Milk of the Different Herds for Eleven Months.

MONTH.				GUERNSEY. Average Percentage of			HOLSTEIN-FRIESIAN. Average Percentage of			JERSEY. Average Percentage of			SHORT-HORN. Average Percentage of		
				Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Total Solids.	Fat.	Solids not Fat.
1889.															
December				14.64	5.11	9.53	12.26	3.64	8.62	14.72	5.02	9.70	12.85	3.81	9.04
1890.															
January				15.29	5.49	9.80	12.26	3.68	8.58	15.19	5.23	9.96	13.44	4.26	9.18
February				15.15	5.32	9.83	12.41	3.73	8.68	15.29	5.31	9.98	13.74	4.45	9.29
March				15.29	5.46	9.83	12.46	3.89	8.57	14.99	5.36	9.63	13.99	4.69	9.30
April				14.95	5.20	9.75	12.39	3.84	8.55	14.83	5.32	9.51	12 76	3.89	8.87
May	[illegible]	[illegible]	[illegible]	14.00	4.57	9.43	12.57	3.65	8.92	13.67	4.30	9.37	12.05	3.24	8.81
June	12.58	3.42	9.16	13.86	4.55	9.31	12.99	3.73	9.26	13 42	4.08	9.34	11.97	3.23	8.74
July	12.72	3.71	9.01	13.85	4.54	9.31	11.44	3.11	8.33	13.46	4.13	9.33	11.89	3.28	8.61
August	13.08	4.07	9.01	13.93	4.81	9.12	11.38	3.05	8.33	13.60	4.22	9.38	12.08	3.56	8.52
September	11.85	3.26	8.59	14.67	5.22	9.45	11.67	3.23	8.44	15.00	5.08	9.92	12.24	8.47	8.77
October	12.27	3.60	8.67	15.28	5.78	9.50	12.08	3.55	8.53	15.75	5.71	10.04	12.61	3.82	8.79
Average	**12.71**	**3.69**	**9.02**	**14.62**	**5.09**	**9.53**	**12.17**	**3.55**	**8.62**	**14.54**	**4.89**	**9.65**	**12.69**	**3.79**	**8.90**

With few notable exceptions the unit of measure with dairymen is either a quart of milk or a pound of butter. As a rule, if derived in a cleanly manner from healthy animals, the actual composition or difference in food values is not taken into consideration. A difference of one or two per cent. in the total solids of the milk or corresponding variations in the pure butter fat of the butter, makes no change in the prices received; hence, a quart of milk or pound of butter fat furnishes a fair basis of comparison for all the breeds.

The results in Table 6 are comparative for all the breeds *only* when it is assumed that, in the complex substance, *total solids*, fat and sugar are of equal value, pound for pound, for it has been shown that the constant factors for all are casein and albumen, and that, for the Jerseys and Guernseys, the fat is five per cent. greater and the sugar five per cent. less than in the other breeds represented.

TABLE 5.

Average Cost of Food Per Quart of Milk.

HERD.	Total number of days under Experiment.	Total Yield of Milk.		Average Daily Yield of Milk.		Cost of Food.		Average Cost of Food per Quart of Milk.
		Pounds.	Quarts.	Pounds.	Quarts.	Total.	Average per Day.	
							cts.	cts.
Ayrshire	1,510	29,845	13,566	19.76	9.0	$226 71	15.0	1.66
Guernsey	1,559	29,785	13,539	19.10	8.7	232 63	14.9	1.71
Holstein-Friesian	1,045	25,366	11,530	24.27	11.0	202 12	19.3	1.75
Jersey	1,251	23,085	10,493	18.45	8.4	201 99	16.1	1.91
Short-Horn	1,604	31,370	14,259	19.56	9.0	247 76	15.4	1.71

In Table 5 the column containing the average yield of milk per day, indicates that on the basis of milk production the five breeds represent three classes, the Guernseys and Jerseys going together as before with an average of 8.5 quarts, the Ayrshires and Short-Horns with an average of 9 quarts, and the Holsteins, a class by themselves, with an average daily yield of 11 quarts, 23 per cent. greater than the first and 18 per cent. greater than the second.

The average cost of the daily rations also varies considerably and in

such a manner as to make the average cost of food per quart of milk very uniform, the lowest, 1.66 cents, being for the Ayrshires, and the difference between the highest and lowest cost but one-quarter of a cent. It should be said, however, that in the case of the Holsteins, the cost of the ration was considerably increased by the fact that the amount of coarse fodder eaten by them was greater than in the other breeds and consisted largely of timothy hay, one of the most expensive foods eaten, which probably did not materially aid in milk production.

TABLE 6.

Average Cost of Food Per Pound of Total Solids.

HERD.	Total number of days under Experiment.	Y			nt of Total Produced Pounds.		Cost of Food.		Average Cost of Food per Pound of Total Solids.
						Average Daily.	Total.	Average Daily.	
								cts.	cts.
Ayrshire............	1,510	29,845	19.76	12.71	3,793.3	2.51	$226 71	15.0	5.9
Guernsey	1,559	29,785	19.10	14.62	4,354.6	2.79	232 63	14.9	5.3
Holstein-Friesian	1,045	25,366	24.27	12.17	3,087.0	2.95	202 12	19.3	6.2
Jersey	1,251	23,085	18.45	14.54	3,356.5	2.68	201 99	16.1	6.0
Short-Horn	1,604	31,370	19.56	12.69	3.980.9	2.48	247 76	15.4	6.2

It is shown in Table 6 that the breed giving the *lowest* average per cent. of solids in the milk produces the greatest amount of milk per day, and that in this breed it is produced in such quantity as to yield the greatest amount of total solids daily. What is true of the Holsteins, however, is not true of the Ayrshires and Short-Horns, for in the case of those breeds the lower quality is not accompanied by a proportionate increase in yield, and the average daily solids is lowest.

A study of Table 7 develops the fact that the cost of food per pound of fat is low in those breeds whose milk shows a high content of fat, and high in those showing a low content of fat; but that the lowest daily averages are not accompanied by the highest cost, and that, on the basis of cost per pound of butter, the breeds are again divided into three classes, which correspond exactly to those shown when the

TABLE 7.

Average Cost of Food per Pound of Fat.

HERD.	Total number of days under Experiment.	Yield of Milk in Pounds. Total.	Yield of Milk in Pounds. Average Daily.	Average per cent. of Fat.	Amount of Fat Produced, in Pounds. Total.	Amount of Fat Produced, in Pounds. Average Daily.	Cost of Food. Total.	Cost of Food. Average Daily.	Average Cost of Food per Pound of Fat.
								cts.	cts.
Ayrshire	1,510	29,845	19.76	3.69	1,101.3	0.73	$226 71	15.0	20.6
Guernsey	1,559	29,785	19.10	5.09	1,516.0	0.97	232 63	14.9	15.3
Holstein-Friesian	1,045	25,366	24.27	3.55	900.5	0.86	202 12	19 3	22.4
Jersey	1,251	23,085	18.45	4.89	1,128.8	0.90	201 99	16.1	17.9
Short-Horn	1,604	31,370	19.56	3.79	1,188.9	0.74	247 76	15.4	20.8

basis is average daily yield of milk, viz., the Guernseys and Jerseys, the Ayrshires and Short-Horns, and the Holstein-Friesians by themselves. The cost per pound of butter fat, as a rule, is greatest in the breeds whose average daily yield of milk is the largest.

Studied under the conditions which now largely rule in the sale of the distinct dairy products, milk and butter, and which must define the present methods of comparison of breeds from the commercial standpoint, the results show that all the breeds do not present the same points of comparison, but are divided into distinct classes, one milk, the other butter. In the milk class the average cost of a quart of milk is less than in the butter class, and in the butter class the average cost of a pound of butter is less than in the milk class.

Further comparisons must await the detailed study of the relative value of the actual food compounds furnished by the milk of each breed, and the bearing of such study upon the present methods of its production, sale and use.

REPORT OF THE CHEMICAL GEOLOGIST.

REPORT OF THE CHEMICAL GEOLOGIST.

In the report for 1889 it was stated that experiments had been begun on certain heavy soils for the purpose of determining the relationship which flocculation of a soil bears to fertility. By flocculation is meant the tendency which the smaller particles have to unite into small aggregates or floccules of considerable tenacity, which floccules appear to serve the purpose of the larger particles of a soil in making the soil loose and loamy.

In the following pages will be found tabulated and discussed such part of the work as had been completed when the investigation closed.

The soils investigated have been very carefully collected according to the method devised by Prof. Hilgard, as described in our last report. In all the soils here described, both surface and subsoil were taken, the latter, when possible, to a depth of at least two feet. The surface soil has, in each case, been designated as A, and the subsoil as B.

The soils were taken from the "trap rock soils," the "Triassic red shale soils," and a few from the "Tertiary soils," and also from soils formed of a mixture of the last two. In almost all of the "red shale" and "trap rock" soils, those soils, namely, formed in place by the decomposition of the underlying rock, very little difference is to be noticed between the surface and subsoil, as far as texture is concerned.

The following is a list, with brief description, of the soils discussed further on, to which is added seven clays that are given for the sake of comparison with the clayey soils.

SOILS ANALYZED.*

I. "TRAP ROCK" SOILS.

No. 3, A and B. Farm of Mr. Wm. H. Coddington, Mount Horeb, Somerset county. Taken from near the west edge of a field

*A—Surface soil. B—Subsoil.

about 1,000 feet northeast of the house, and lying east of the peach orchard. In this place the soil has probably never been cultivated. Its color is a deep red, which would indicate that the soil is fertile, as is the case with the adjacent cultivated fields. It changes to a redder color at 6 inches depth.

A contains 1.5 per cent. gravel larger than 2 millimeters.

B contains 0.5 per cent. gravel larger than 2 millimeters.

No. 4, A and B. Farm of Mr. Tunis Van Nest, Bernards township, Somerset county. It is of a reddish color, and is considered to be an exceedingly good soil. It has been long under cultivation, having been last fertilized three years before the sample was collected. It is almost free from stones. The color changes but slightly at a depth of 8 inches.

A contain 1.8 per cent. gravel larger than 2 millimeters.

B contains 0.7 per cent. gravel larger than 2 millimeters.

No. 5, A and B. Farm of Mr. E. Weber, Bernards township, Somerset county. Taken from the peach orchard in a spot where the trees do not thrive. At time of collecting, the soil had not been fertilized for four years. The surface soil is slightly reddish, and changes at six inches to a yellow color. The subsoil is very tenacious and crushes with difficulty.

A contains 0.8 per cent. gravel larger than 2 millimeters.

B contains 0.5 per cent. gravel larger than 2 millimeters.

No. 6, A and B. Taken but a few spaces from No. 5. On this spot, as in most of the orchard, the peach trees thrive well. To all appearance the soil is the same as No. 5. The subsoil, however, is of a slightly redder color.

A contains 1.7 per cent. gravel larger than 2 millimeters.

B contains 11.7 per cent. gravel larger than 2 millimeters.

No. 10, A and B. Farm of Mr. G. W. Durling, on the east end of Sourland Mountain, Somerset county. The soil is light and loamy. Color reddish. It has not been under cultivation for many years, but is said to be fertile. At eight to ten inches depth the color changes very little.

A contains 9.4 per cent. gravel larger than 2 millimeters.

B contains 5.6 per cent. gravel larger than 2 millimeters.

No. 11, A and B. Farm of Mr. W. B. McFarland, Rocky Hill, Somerset county. Soil taken in woodland several hundred paces south of the house. It has never been cultivated, but closely

resembles the soil of Mr. McFarland's garden (see No. 13), which is an excellent soil. The color is red. It appears to be loamy, but is quite sticky when pressed between the fingers. No distinct line of color separates the surface from the subsoil. A few yellow quartz pebbles indicate the proximity of tertiary gravel.

A contains 4.3 per cent. gravel larger than 2 millimeters.

B contains 6.0 per cent. gravel larger than 2 millimeters.

No. 12, A and B. A poor soil taken from a wet meadow about half way between No. 11 and the house of Mr. McFarland. Soil is very heavy and sticky. Color a mottled yellow and gray. At six inches changes to a sticky clay of reddish-brown and gray colors. It contains a few tertiary pebbles.

A contains 3 per cent. gravel larger than 2 millimeters. This consists of quartz pebbles and little gobular concretions of carbonate of iron (sphracrosiderite).

B contains 7 per cent. gravel larger than 2 millimeters, consisting of quartz pebbles.

No. 13, A and B. From the vegetable garden of Mr. W. B. McFarland, of Rocky Hill. Probably the same soil as No. 11. Has been long under high cultivation. Color, dark red, becoming much redder at a depth of about six inches. The subsoil contains numerous fragments of trap rock. A few tertiary quartz pebbles are scattered through the soil. When dry the soil clings together in lumps which are easily broken up.

A contains 11 per cent. gravel larger than 2 millimeters.

"TRIASSIC" AND "TERTIARY" SOILS.

No. 8, A and B. Farm of Mr. Sam. Barber, east end of Sourland Mountain, Somerset county. This is a poor soil. It is from an indurated, dark-colored slate. Both surface and subsoil are of a dark-gray color, and are exceedingly heavy and clayey.

No. 15, A and B. Probably a tertiary soil, from the woodland one-half mile south of the house of Mr. W. B. McFarland, Rocky Hill, Somerset county. The soil is very wet and dark-colored, sometimes almost black, due to the presence of organic matter. The subsoil is of a mottled yellow and blue color. Both surface and subsoil are heavy and clayey. This soil contains almost no gravel larger than 2 millimeters.

No. 16, A and B. From the College farm, New Brunswick. A mixed red shale and tertiary, pebbly soil, taken from a long strip of poor soil, running in an east-west direction in the midst of good soil, at the southern end of the farm. The ground is nearly level, and has been drained and under cultivation for some sixteeen years. The soil is heavy, cakes badly, and is very plastic when pressed in the hand. The color is gray. Below six to eight inches it changes to a mottled yellowish or reddish-yellow and gray clay, in which are frequently many pebbles.

A contains 2.5 per cent. gravel larger than 2 millimeters.

B contains 2 per cent. gravel larger than 2 millimeters.

No. 17, A and B. From the same field as No. 16, but taken from the good soil on a slight knoll 100 paces to the north. This soil appears to be the same as No. 16. The subsoil, however, is a little more reddish, and somewhat looser. It contains considerable gravel.

A contains 8 per cent. gravel larger than 2 millimeters.

B contains 20 per cent. gravel larger than 2 millimeters.

No. 18, A and B. Red shale soil from the farm of Mr. J. Stothoff, Franklin township, near New Brunswick. It is from a poor strip running northeast and southwest across the farm, and is underlaid by what is locally termed "blue shale." It is of a dark-red color, and is only about a foot thick, lying on a bluish or violet-colored shale. The subsoil consists very largely of loosened shale.

A contains 19 per cent. gravel larger than 2 millimeters.

B contains 37 per cent. gravel larger than 2 millimeters.

No. 18, A and B. A good soil from a strip of land running parallel to that from which No. 18 was taken, and lying in an adjacent field. It appears to be slightly sandy, is of a dark-reddish color and contains numerous fragments of shale. The rock lies two feet below the surface.

No. 23, A and B. Red shale soil from the farm of Mr. S. G. Williams, Franklin township, near New Brunswick. The soil, which is considered to be the best on the place, is of a deep-red color, clayey, and contains many quartz pebbles. No marked change of color is seen on going down. At about 10 inches the shale rock is struck.

No. 24, A and B. A red shale soil from the northern edge of the College farm, New Brunswick. It is a poor soil, on account of being very heavy and sticky and caking badly. The color is intensely-deep red, and no very marked change is noticeable between

the surface and subsoil. This comes from a narrow strip of land having a northeast to southwest trend and bounded by good soil on both sides.

A contains 12 per cent. gravel larger than 2 millimeters.

LIST OF CLAYS.

No. I. Raritan fire clay. New Jersey Clay and Brick Company's pits, Bonhamtown, Middlesex county.

No. II. "Stained white clay" (fire clay). Valentine's pits, Ford's Corners, Middlesex county.

No. III. Slate-colored "top clay." Valentine's pits, Ford's Corners.

No. IV. "Stained red clay," at bottom of fire clay. Valentine's pits, Ford's Corners.

No. V. "Sandy clay, No. 2," bottom of fire clay. Valentine's pits, Ford's Corners.

No. VI. "White fire clay." Same bed as No. II. Valentine's pits, Ford's Corners.

No. VII. "Raritan potters' clay" (red clay). From S. Meeker's, west of Bonhamtown, Middlesex county. (Is very plastic.)

A mechanical analysis of these soils has been carefully made for the purpose of finding the relationship that exists, if any, between the size of the soil particles and fertility. The method of analysis used was the "Beaker Elutriation" method, devised by Dr. T. B. Osborne. In preparing the soils they were first air-dried and then put through a sieve with round holes 2 millimeters = $\frac{1}{12}$ inch in diameter. All the solid material larger than 2 millimeters in diameter is designated "gravel," and has been left out of account in these analyses, as it is not likely that the gravel very materially affects the fertility, unless, as is not the case, it is very abundant. The soil, therefore, freed from gravel, has been separated by this method of analysis into six grades of materials, as follows: First, "sand," larger than 0.25 millimeters = $\frac{1}{100}$ inch; second, "sand," 0.25 to 0.05 millimeters = $\frac{1}{100}$ to $\frac{1}{500}$ inch; third, "silt," 0.05 to 0.01 millimeters = $\frac{1}{500}$ to $\frac{1}{2500}$ inch; fourth, "dust," smaller than 0.01 millimeter; fifth, "clay," which consists of material so fine that it remains in suspension in a column of water 10 inches high after 24

hours' standing; sixth, "organic matter + water," obtained by determining the loss in weight upon igniting the soil.

The following table, No. I., contains the analyses of all the soils and of two of the clays. It may be stated here that these mechanical analyses do not pretend to have the accuracy of chemical analyses, as such accuracy is not possible nor necessary. All the individual separations were weighed upon chemical balances, but the original sample upon less accurate balances. This fact, together with the fact that with some of the analyses (mostly the earlier ones) sufficient care was not taken to prevent the absorption of water from the air during cooling and weighing, will explain the cases where the sum is over 100 per cent. This, however, is of little or no consequence. In the case of the clays, it was found impracticable to air-dry them, as this rendered them so hard that upon subsequent wetting they refused to separate into their constituents again. It was therefore necessary to weigh them wet and calculate the probable weight when air-dried. This introduces an additional source of error.

For the better comparing of results these analyses have been reduced to 100 per cent., and thus given in the adjoining table, No. II.

TABLE I.

Mechanical Analyses of Soils.

No. of Soil.	LOCATION OF SOIL.	Character of Soil.	Sand, > 0.25 mm.	Sand, 0.25–0.05 mm.	Silt, 0.05–0.01 mm.	Dust, < 0.01 mm.	Clay.	Organic Matter + Water.	Sum.
3 A	Surface Soil (Trap), farm of Wm. H. Coddington, Mt. Horeb, Somerset Co	Virgin good.	1.65	8.41	58.72	16.63	2.63	11.04	99.08
4 A	Surface Soil (Trap), farm of Wm. H. Coddington, Mt. Horeb, Somerset Co	Cult. good.	2.90	8.19	56.16	18.10	5.83	8.92	100.10
5 A	Surface Soil (Trap), farm of E. Weber, Bernards Township, Somerset Co	Cult. poor.	1.19	8.44	58.90	16.69	5.65	8.22	99.09
5 B.	Subsoil, same as 5 A	Cult. poor.	1.22	7.89	49.42	22.88	7.99	9.03	98.43
6 A	Surface Soil, close to 5 A	Cult. good.	1.78	7.90	57.82	16.87	6.65	8.44	99.46
6 B	Subsoil, same as 6 A	Cult. good.	6.30	11.66	44.88	15.43	10.32	11.60	100 19
8 A	Surface Soil (Indurated Slate), farm of Sam'l Barber, Sourland Mt., Somerset Co	Cult. poor.	2.34	9.76	44.09	24.13	7.07	11.50	98.89
10 A.	Surface Soil (Trap), farm of G. W. Durling, east end Sourland Mt., Somerset Co	Cult. good.	13.13	17.69	35.92	14.09	5.86	11.41	98.10
11 A.	Surface Soil (Trap), woodland, farm of W. B. McFarland, Rocky Hill, Somerset Co.	Virgin good.	9.75	19.06	39.22	14.63	5.86	11.76	100.28
12 A	Surface Soil (Trap), wet meadow, same farm as 11 A	Cult. poor.	11.79	17.81	38.55	17.27	5.91	8.76	100.09
13 A.	Surface Soil (Trap), garden of same farm as 11 A	Cult. good.	17.01	20.24	28.15	14.49	6.18	12.80	98.87
15 A	Surface Soil (Tertiary), woodland on same farm as 11 A	Virgin very wet.	11.01	30.83	36.53	10.40	4.64	6 22	99.63
16 A	Surface Soil (Mixed Shale an	Cult. poor.	13.81	24.18	30.97	15.77	7.70	7.06	99.49
17 A	Su le an	Cult. good.	26.31	18.49	30.00	17.49		7.71	100.00
18 A.	Su , far t Co	Cult. poor.	24.09	11.57	29.90	17.20	6.91	8.88	98.47
19 A	Su , far t Co	Cult. good.	41.20	23.51	17.68	7.90	2 18	5.20	99.67
23 A	Su farm et Co	Cult. good.	21.04	16.94	23.03	17.38	8.90	11.56	98.85
24 A.	Su , Col	Cult. poor.	15.48	16.29	25.64	17.74	11.95	13.00	100.10
Clay III	"Slate-colored Top Clay," Valentine's Pit, Ford's Corner, Middlesex Co	....	none.	3.60	44.20	23.90	19 23	7.10	98.03
Clay VII.	"Raritan Potters' Clay" (Red), from S. Meekers, west of Bonhamtown, Middlesex Co	....	none.	0.54	30.04	29.04	33.92	6.73	100.94

TABLE II.

Mechanical Analyses of Soils, Reduced to 100 Per Cent.

No. of Soil.	LOCATION OF SOIL.	Character of Soil.	Sand, > 0.25 mm.	Sand, 0.25–0.05 mm.	Silt, 0.05–0.01 mm.	Dust, < 0.01 mm.	Clay.	Organic Matter + Water.	Sum.
3 A.	Surface Soil (Trap), farm of Wm. H. Coddington, Mt. Horeb, Somerset Co.	Virgin good.	1.66	8.49	59.27	16.78	2.66	11.14	100.00
4 A.	Surface Soil (Trap), farm of Wm. H. Coddington, Mt. Horeb, Somerset Co.	Cult. good.	2.90	8.18	56.10	18.08	5.83	8.91	100.00
5 A.	Surface Soil (Trap), farm of E. Weber, Bernards Township, Somerset Co.	Cult. poor.	1.20	8.52	59.44	16.84	5.70	8.30	100.00
5 B.	Subsoil, same as 5 A.	Cult. poor.	1.24	8.02	50.20	23.24	8.12	9.18	100.00
6 A.	Surface Soil, close to 5 A.	Cult. good.	1.79	7.94	58.13	16.96	6.69	8.49	100.00
6 B.	Subsoil, same as 6 A.	Cult. good.	6.29	11.64	44.79	15.40	10.30	11.58	100.00
8 A.	Surface Soil (Indurated Slate), farm of Sam'l Barber, Sourland Mt., Somerset Co.	Cult. poor.	2.36	9.87	44.59	24.40	7.15	11.63	100.00
10 A.	Surface [illegible] of G. W. Durling, east end Sourland Mt, Somerset Co.	Cult. good.	13.39	18.03	36.61	14.36	5.98	11.63	100.00
11 A.	Surfa[illegible] woodland, farm of W. B. McFarland, Rocky Hill, Somerset Co.	Virgin good.	9.72	19.01	39.11	14.59	5.84	11.73	100.00
12 A.	Surface Soil (Trap), wet meadow, same farm as 11 A.	Cult. poor.	11.77	17.80	38.52	17.26	5.90	8.75	100.00
13 A.	Surface Soil (Trap), garden of same farm as 11 A.	Cult. good.	17.21	20.47	28.47	14.66	6.25	12.94	100.00
15 A.	Surface Soil (Tertiary), woodland on same farm as 11 A.	Virgin very wet.	11.05	30.94	36.67	10.44	4.66	6.24	100.00
16 A.	Surface Soil (Mixed Shale and Tertiary), College Farm, New Brunswick.	Cult. poor.	13.88	24.30	31.13	15.85	7.74	7.10	100.00
17 A.	Surface Soil [illegible] Tertiary), College Farm, New Brunswick.	Cult. good.	26.31	18.49	30.00	17.49		7.71	100.00
18 A.	Surface Soil [illegible] of J. [illegible] Somerset Co.	Cult. poor.	24.47	11.75	30.36	17.38	7.02	9.02	100.00
19 A.	Surface Soil [illegible] of J. [illegible] Somerset Co.	Cult. good.	41.34	25.59	17.74	7.93	2.19	5.21	100.00
23 A.	Surface Soil ([illegible] of S. G. [illegible]), Somerset Co.	Cult. good.	21.28	17.14	23.30	17.58	9.00	11.70	100.00
24 A.	Surface Soil [illegible]ege Farm, New Brunswick.	Cult. poor.	15.47	16.27	25.61	17.72	11.94	12.99	100.00
Clay III.	"Slate-colore[illegible]entine's Pit, Ford's Corner, Middlesex Co.	....	none.	3.67	45.09	24.39	19.61	7.24	100.00
Clay VII.	"Raritan Potters' Clay" (Red), from S. Meekers, west of Bonhamtown, Middlesex Co.	....	none.	0.54	29.76	20.43	33.60	6.67	100 00

TABLE III.

Mechanical Analyses of Red Shale and Tertiary Soils.

	Number of Soil.	Sand, > 0.25 mm.	Sand, 0.25-0.05 mm.					
Good soils	17 A	26.31	18.49	30.00	17.49		7.71	100
	19 A	41.34	25.59	17.74	7.93	2.19	5.21	100
	23 A	21.28	17.14	23.30	17.58	9.00	11.70	100
Averages		29.64	20.41	23.68	12.75	5.60	8.21	
Poor soils	8 A	2.36	9.87	44.59	24.40	7.15	11.63	100
	15 A	11.05	30.94	36.67	10.44	4.66	6.24	100
	16 A	13.88	24.30	31.13	15.85	7.74	7.10	100
	18 A	24.47	11.75	30.36	17.38	7.02	9.02	100
	24 A	15.47	16.27	25.61	17.72	11.94	12.99	100
Averages		13.44	18.63	33.67	17.16	7.70	9.40	

TABLE IV.

Mechanical Analyses of Trap Soils.

	Number of Soil.	Sand, > 0.25 mm.	Sand, 0.25-0.05 mm.	Silt, 0.05-0.01 mm.	Dust, < 0.01 mm.	Clay.	Organic Matter + Water.	Sum.
Good soils	3 A	1.66	8.49	59.27	16.78	2.66	11.14	100
	4 A	2.90	8.18	56.10	18.08	5.83	8.91	100
	6 A	1.79	7.94	58.13	16.96	6.69	8.49	100
	6 B	6.29	11.64	44.79	15.14	10.30	11.58	100
	10 A	13 39	18.03	36.61	14.36	5.98	11.63	100
	11 A	9.72	19.01	39.11	14.59	5.84	11.73	100
	13 A	17.21	20.47	28.47	14.66	6.25	12.94	100
Averages		7.57	13.39	46.07	15.79	6.22	10.92	
Poor soils	5 A	1.20	8.52	59.44	16.84	5.70	8.30	100
	5 B	1.24	8.02	50.20	23.24	8.12	9.18	100
	12 A	11.77	17.80	38.52	17.26	5.90	8.75	100
Averages		4.74	11.45	49.39	19.11	6.57	8.74	

In Tables III. and IV. there are given separately the results of these analyses for red shale and tertiary soils and for trap rock soils. In each table the good and poor soils are separated.

It is to be noticed that the amount of organic matter and water seems to bear little relationship to the fertility, and this might well be expected, as, in cultivated land, the organic matter is largely dependent upon the amount and nature of the fertilizer. For example, the amount of organic matter and water is unusually large in 24 A and in 13 A, both soils that are very abundantly fertilized mostly or exclusively with barn-yard manure.

In the case of the clay, there appears to be a slight preference in favor of the soil with little clay, and yet the difference is very small. It may be noted how very small the amount of clay is in even the heaviest soils. Though these soils are all rather clayey, the average percentage of clay is only a little over nine.

As to the other ingredients, we may draw a line separating the sand of both grades from the silt and dust. All to the left of the line, namely, all the sand, is in excess in the good soil; all to the right, namely, the finer silt and dust, is in excess in the poor soils. This is especially marked in the red shales and tertiary soils, but not so much so in the trap rock soils. The general scarcity of the coarser materials in the latter may account in part for the difference being so little between the good and poor soils. The exceptions to this in individual soils are quite inconsiderable, when considering that no account is taken here of probable differences in chemical composition.

It is well known that the trap rock soils yield much poorer results on the average than the red shale soils, when under cultivation. During a dry season, however, the former have the advantage, as they hold the water better. This experience agrees with the analyses in these two tables. On comparing the two, it is seen that the better of the trap rock soils contain over 60 per cent. silt and dust, while the better of the red shale soils contain but little over 35 per cent. of the same.

THE FLOCCULATION OF SOILS.

While endeavoring to make a mechanical analysis of some of the trap rock soils, it was for a while found almost impossible to separate one or two of them (particularly the subsoil of No. 6) into the differ-

ent grades of fineness, on account of the pertinacity with which the floccules of the silt and dust particles clung together. Long-continued pestling failed to break them up, as did also six hours of boiling. As it is known, however, that alkalies tend to break up flocculation, a small drop of ammonia was added with the effect that upon simply stirring with a glass rod the floccules separated and did not show a great tendency to re-form, although washed with pure water. Thereafter a little ammonia was regularly used in separating the soils, and experience shows that a soil so treated will require much less pestling to prevent the formation of floccules. It must be remembered, however, that even a minute quantity of free ammonia will prevent the subsequent settling of the clay upon addition of ammonium nitrate. This, of course, must be obviated by the addition of a little nitric acid, an excess of acid being desirable, as it assists in bringing down the clay.

To determine to what extent these soils are in a natural state of flocculation, and what relationship exists between flocculation and fertility, the following settling experiments were made:

Preliminary experiments were first made with seven clays from the clay pits near Ford's Corners and near Bonhamtown, Middlesex county. These being nearly free from organic matter and coarser sand, results were obtained quite different from those of soils where both are present.

In Tables V., VI. and VII., there are given the results of settling experiments with clays and with soils. For this purpose beakers five centimeters in diameter were employed. Five grammes of soil or clay were taken, and for the purpose of removing the coarsest sand it was put through a sieve with 0.25-millimeter holes. The beakers were then filled with water to a depth of four centimeters. After thorough stirring there was noted—1st. The time required for the soil or clay to settle. 2d. The condition of the sediment after a given lapse of time. For convenience' sake the water above is said to be clear when coarse printing can be read through the water.

TABLE V.

Experiment with Settling of Clays.

	UPPER HALF CLEAR.	LOWER HALF.	CLAY ON THE BOTTOM AFTER TWO WEEKS.
Clay I.....	18 hours.	All except III. settle down finally to a curdy, flocculated mass, occupying one-half to two-thirds of the lower half. III. settles to about half the bulk of the others, the liquid remaining a long time clouded.	Very loose, clings slightly to bottom.
Clay II.....	30 minutes.		Same as I.
Clay III.....	72 hours.		Thin, loose layer on top, the rest compact, clinging somewhat.
Clay IV.....	2 hours.		Same as I.
Clay V.....	18 hours.		Same as I.
Clay VI.....	30 minutes.		Same as I.
Clay VII.....	1 hour.		Same as I.

With the exception of III., all these clays settle slowly in a mass, leaving above either a limpid or a hazy liquid. The line of demarkation is very sharp, like that between oil and water. The surface of the clay liquid may be considerably disturbed (with a glass rod or a gentle stream of water from a wash bottle) without being sufficiently broken to allow the clay to become mixed with the clear water above.

III. settles slowly to a much more compact mass, the heaviest going down first.

By the addition of a small drop of strong ammonia to each of these clays the floccules are broken up, and instead of settling, as above described, to a curdy mass, the material remains suspended a very long time, gradually arranging itself, according to the size of the particles, in from four to six easily recognizable bands which differ in color as well as texture.

After four months' standing the liquid of I., III., and IV. A is slightly brownish, of the others clear but slightly opalescent. The sediment of all was two to three millimeters thick. In all but VI. and VII., there remained above the sediment a thin, cloudy layer, which, upon tipping the beaker, flowed down to the lowest side, acting like a heavy liquid. This represents the upper layer of sediment that after four months still remained suspended.

TABLE VI.

Experiment in Settling with Trap Soils.*

	UPPER HALF CLEAR.	LOWER HALF CLEAR.	SEDIMENT AFTER 24 HOURS.	WATER AFTER TWO WEEKS.
3 A.........	36 hours.	57 hours.	Compact; does not cling to bottom..	Pearly.
3 B.........	2 hours.	3½ hours.	Very loose; does not cling	Limpid.
4 A.........	48 hours.	More than 72 hours.	Rather compact; does not cling...	Pearly; cloudy at bottom.
4 B.........	5 hours.	7 hours.	Very loose; does not cling	Limpid.
5 A.........	48 hours.	57 hours.	Compact; does not cling	Pearly.
5 B.........	4 hours.	5 hours.	Very loose; does not cling	Limpid.
6 A.........	48 hours.	72 hours.	Compact; does not cling	Pearly.
6 B.........	2½ hours.	3½ hours.	Very loose; does not cling.........	Limpid.
10 A.........	60 hours.	More than 72 hours.	Compact; does not cling	Pearly.
10 B.........	3 hours.	4 hours.	Very loose; does not cling.........	Limpid.
11 A.........	37 hours.	72 hours.	Compact; does not cling	Pearly.
11 B.........	24 hours.	48 hours.	Loose; does not cling	Pearly.
12 A.........	60 hours.	More than 72 hours.	Compact; does not cling...	Pearly.
12 B.........	60 hours.	More than 72 hours.	Loose; does not cling...	Pearly.
13 A.........	72 hours.	More than 72 hours.	Compact; does not cling...	Pearly.
13 B.........	3 hours.	3 hours.	Rather loose; does not cling	Limpid.

*In Tables VI. and VII., as elsewhere, A = surface soil, B = subsoil.

TABLE VII.

Experiment in Settling with Red Shale and Tertiary Soils.

	UPPER HALF CLEAR.	LOWER HALF CLEAR.	SEDIMENT AFTER 24 HOURS.	SEDIMENT AFTER THREE MONTHS.
8 A......	48 hours.	48 hours.	Rather compact; does not cling...	
8 B......	11 hours.	24 hours.	Loose; does not cling...............	
15 A......	60 hours.	60 hours.	Compact; does not cling...............	Compact; clings.
15 B......	12 hours.	24 hours.	Loose; does not cling...............	Loose on top; clings somewhat.
16 A......	60 hours.	More than 72 hours.	Compact; does not cling...............	Compact; clings.
16 B......	60 hours.	More than 72 hours.	Loose; does not cling...............	Loose on top; does not cling.
17 A......	30 hours.	More than 72 hours.	Rather compact; does not cling...	Compact; clings.
17 B......	24 hours.	More than 72 hours.	Loose; does not cling...............	Loose on top; clings somewhat.
18 A......	72 hours.	More than 72 hours.	Compact; does not cling...............	Compact; clings.
18 B......	72 hours.	More than 72 hours.	Somewhat loose; does not cling...	Compact; clings somewhat.
19 A......	36 hours.	More than 72 hours.	Compact; clings a little...............	
19 B......	36 hours.	More than 72 hours.	Rather loose; clings very little.	
23 A......	More than 72 hours.	More than 72 hours.	Compact; does not cling...	
23 B......	34 hours.	More than 72 hours.	Rather loose; does not cling.........	
24 A......	More than 72 hours.	More than 72 hours.	Compact; does not cling...............	
24 B......	48 hours.	More than 72 hours.	Loose; does not cling...	

The clays, with exception of No. III., are remarkably flocculated, the result being that they settle very rapidly, leaving the water above limpid in most cases, and, after settling, the sediment remains in a loose mass, very voluminous, and refuses to become compact and firm even after months' standing. The one exception is clay No. III., which, from the analysis given in Table No. III., more nearly resembles a natural soil in its mechanical composition. This clay has a rather gritty feel. Clay No. VII. was taken for analysis to represent the other extreme. It is entirely free from grit, and is exceedingly plastic. From Table II. it is seen that it contains fully 33 per cent. of pure clay.

Turning now to the soils, it is to be noted, first, that in nearly all cases the subsoil is more flocculent than the surface soil. This is seen in the rapidity with which the former settles, leaving in some cases the water above quite limpid, also in the loose condition of the sediment; second, that the trap soils are, as a rule, more highly flocculent than the others. The principal exception is No. 12, which represents a very poor soil.

This tendency of the trap soils to flocculate is undoubtedly a redeeming feature, as the good and poor soils belonging to the red shale and tertiary areas do not appear to show this difference.

It would appear, therefore, that the very fine-grained soils naturally tend to flocculate. What breaks up the floccules at the surface is not so clear, whether the action of the frost or the mechanical action of the plow, or whether it is produced by the action of chemical agents. The effect of free ammonia, mentioned above, in breaking up the floccules, would seem to indicate that the last is an effective cause, as free ammonia is generally present in soils. This suggests that the too free use of ammonia-forming fertilizers, as of manure, may very possibly have the effect of rendering the soil heavy by breaking up the floccules. On the other hand, the well-known action of lime on heavy soils is to make the soil light by assisting in the formation of floccules.

It is to be remarked, in conclusion, that upon comparing together the two soils 5 and 6, both from the same peach orchard (that of Mr. E. Weber, Bernards township, Somerset county), the former being apparently poor and the latter good, there appears to be no very marked difference, to judge from these experiments, such as would explain why the peach trees should fail on one spot and flourish on

the other. There is, however, a slight difference in favor of the good ground. No. 6 appears to be somewhat more flocculated than No. 5. The mechanical analysis given in Table IV. is almost identical for the surface soil, while for the subsoil (B), the better soil (6) contains more sand than the poorer soil. It may be noted in passing, moreover, that the subsoil in both 5 and 6 is slightly coarser grained. This is in all probability due to the action of frost in pulverizing the surface soil. In the case of this orchard it is possible the real trouble lies outside of the soil, and may be sought for in some parasitic pest.

HORACE B. PATTON.

REPORT OF THE BIOLOGIST.

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OSTRACULTURAL EXPERIMENTS.

§ 1. *Acknowledgments.*

In our two preceding reports on the Oyster Industry of New Jersey and on Oyster Culture, we gave the reasons which demand and justify the series of experiments begun last summer (1890), which are exhibited in detail in the following pages. At the outset we desire to acknowledge the great services of several gentlemen, practical oystermen, who have aided the writer in many substantial ways, not to mention their courtesy and kindness in the little things that defy specific mention. In the first place, the tables of temperature, density, etc., of the sea-water at different points on the coast, near planted oyster-beds, owe their existence to the labors of several volunteer observers who took the trouble to make these records without remuneration. Capt. James E. Noe, of Perth Amboy, Joseph Aumack, oyster watchman at Keyport, and Capt. Chas. E. Allen, of Oceanic, deserve the credit for this portion of our report. The above-mentioned gentlemen, in addition to Capt. James Bedle, of Keyport, also deserve thanks for their efforts in furnishing the oysters used in the experiments. Capt. Chas. Allen also gave me laboratory quarters and participation in the hospitalities of his home while I was at Oceanic. At Keyport, Capt. T. S. R. Brown, ever ready to aid the cause of progressive oyster culture, gave me laboratory facilities on the second floor of his store, which as respects comfortable housing, light, tables, etc., were all that could be desired.

§ 2. *Laboratory Equipment.*

The laboratory was furnished by the experimenter (and Experiment Station) with a Leitz microscope with two oculars and two objectives (giving magnifying powers ranging from sixty-five to six hundred

diameters), and the following list of accessories: 1 dozen solid (biological) watch-glasses; 4 dozen small glass dishes (salt-cellars); 2 large glass dishes; 2 tumblers; 2 tin and 1 wooden buckets; 1 glass graduate of five cubic centimeters capacity; several vials of alcohol for receiving samples for histological examination; several empty bottles; several bottles of sea-salt; several bottles of "sea-salt solution" of varying strengths; a quantity of glass slides; a medicine dropper; Holman's siphon life-box; biological scissors, forceps and scalpel; and finally an oyster-knife, furnished by Capt. Brown.

For the volunteer observers, the experimenter prepared an instrument constructed as follows: A glass cylinder 14 inches high was enclosed in a wire cage weighted below, and hung to a cord above by elastic rubber bands. The cord passes between the elastic bands and ends in a hook so adjusted that it can clasp a hook fastened to the cork that closes the mouth of the glass, and of such length that when the rubber bands stretch the cork is pulled out. To use the instrument it is lowered to the bottom of the sea and by a few jerks of the cord the cork is extracted, the cessation of escaping bubbles indicating when the cylinder has filled. The water is drawn up and tested with a combined hydrometer and thermometer. Unfortunately the hydrometer was not sensitive enough for the purposes of oyster culture, as later experiments proved, it being difficult to read the instrument closer than one degree (per centum).

§ 3. *Artificial Sea-Water.*

Three sorts of artificial sea-water were made. First from pure salt (sodium chloride), designated in our experiments "salt solution." The second from commercial "sea-salt," which is probably only common unrefined rock-salt, designated "sea-salt solution." Thirdly, a composition compounded of the different ingredients found in the ocean, in the following proportions, and termed "artificial sea-salt:"

	Parts (grains, for example).
Sodium chloride	777.58
Magnesium chloride	108.78
Magnesinm sulphate	47.37
Calcium sulphate	36.00
Potassium sulphate	24.65
Magnesium bromide	2.17
Calcium carbonate	3.47

The most important of these ingredients are undoubtedly the first and the last, calcium carbonate being used by the oyster for shell-building. But this salt will not dissolve in water, except in very minute proportions, and then not, except the water contains carbonic acid gas. If the carbonate of lime be added to excess, the water will not take up enough to injure the oyster. Experiment must decide, whether the other ingredients of sea-water can be varied in amount without affecting the oyster.

§ 4. *Ostracultural Problems.*

While it is easy to propound numerous questions bearing on oyster culture, with only a superficial knowledge of what is already known, it will be found true that these questions begin to take definite shape and to mass up in numbers, only as a person studies the subject experimentally. The following list is the outcome of our experience, and while it is long, it is far from complete. The questions are first grouped into the numbered ones and these are grouped in the lettered series, in order to facilitate additions in the future. The work necessary to be done to answer these questions in a scientific manner is so vast that unless numerous workers, all along the shore and in neighboring States, aid me in the solution of them, it will take a long time before oyster culture arrives at that stage of perfection at which I aim. Let the workers come with their aid and contributions to our knowledge of this subject.

Series A. Ætiology.

1. What are the distinguishing characteristics of the seed from different natural beds, as regards shell, growth, flavor, etc.?
2. What are the distinguishing physical features of different beds as to soil, oyster food, climate, etc.?
3. To what extent are the oysters of one locality modified when bred upon, or transplanted to the other localities?
4. What physiological characters distinguish the varieties, such as date and length of spawning period, rapidity of development of the sexual cells in the reproductive glands, and, after fertilization, the rapidity of growth of the young oyster?
5. To what extent are these physiological characteristics influenced by the soil, food, climate, etc., of a region?

Series B. Physiology of Adult.

1. Is it possible to ascertain any constant difference between the sexes without opening the shell?

2. How early in the life of an oyster is it possible to distinguish the difference in sex by examination of the reproductive glands?

3. How early in the season do the sexual cells of an oyster begin their maturation?

4. What biological and chemical changes accompany maturation, also restoration (fattening) after spawning?

5. How often do oysters spawn in one season?

6. Is the sex of an oyster constant?

7. How is the sexual ratio influenced by the environment?

8. What chemical differences are there between males and females?

9. Do oysters hibernate; when, how long, how influenced by temperature, etc.?

10. How long will an oyster live out of water under different conditions of temperature and moisture, and at different seasons?

11. What effects are produced on the sexual cells by such unnatural conditions?

12. How long will the sexual cells survive the death of the oyster?

13. How do different inorganic and organic substances in solution in sea-water affect the oyster at different ages?

Series C. Physiology of the Embryo.

1. How soon does the embryo begin to eat?

2. What food is best for the embryo?

3. What position relative to bottom is most favorable to the growth of oyster "spat?"

Series D. Reproduction.

1. What conditions of weather, etc., favor the spawning of oysters?

2. How long does it take an oyster to complete spawning?

3. How long will the eggs and spermatozoa live before union without deterioration?

4. How far is the spawn carried by currents before fixation of the spat?

5. How does the temperature and saltness of water influence the destruction of spawn?

6. How does temperature and saltness influence the rate of development?

7. What is the relation between subaqueous climate and the production of a "set?"

8. What characters do ripe sexual cells (gametes) show as distinguished from unripe ones?

9. Are all the gametes ripe at the same time?

Series E. Enemies.

1. What parasites infest the oyster at different seasons?

2. How does muddiness of the water affect the oyster at different stages?

3. What predatory enemies attack the oyster at different times, and what extent of damage is wrought?

4. What conditions of environment are unfavorable to these enemies while favorable to the oyster?

5. How can enemies be best combated?

6. What conditions cause the pathological development of the spawn?

Series F. Economic.

1. Are oysters good for food when in spawn? If not, why?

2. Should the times when oysters may be taken or sold be regulated by law?

3. What are the effects of "freshening" of oysters?

Series G. Technical.

1. How can ripe eggs be separated from those not mature?

2. How can the embryos be separated from deleterious matters?

3. How can embryos best be fed and cared for?

4. How can embryos be given the best means of fixation?

5. How can the oyster of several months' age be artificially fed and fattened?

6. To what extent is it possible to keep large oysters in limited supplies of water?

7. What is the best dilution of the milt to secure the most successful impregnation of the eggs?

SERIES F. EMBRYOLOGY.

Questions under this head reserved for future indication.

§ 5. *Methods of Experimentation and Explanation of Terms Used.*

Before the experiments here recorded were made, no systematic plan of operation had been outlined. The order apparent in our present report is the result of experience and after-study of the data. But it seems best to present the results as though this order was followed from the beginning, that the record may be clear to the reader. It is needless to say that had the system been used from the start, the gaps in various of our tables would have been less numerous.

We placed a certain limitation to the extent of field to be covered by experiment, viz., the study of only those questions that bear upon the viability of the eggs and spermatozoa in different solutions, and we allowed the conditions of our environment, accessibility of material, etc., to guide us in the planning of the possible experiments.

CATALOGUING THE OYSTERS.

The oysters received are first labeled with a number and entered on a record (as in the table) showing the date of reception, the locality whence seed obtained, where planted; and other remarks, such as appearance, weight, how long planted, shifting, etc., are desirable. Have the oysters been freshened or not? is an important question. When the oyster is opened, the date of this event is added to the record, as well as the condition of the reproductive gland (gonad) and of the sexual elements (gametes). Some examination should be made of the contents of the stomach, and the parasites, etc., noted.

DESIGNATING THE OYSTERS.

While an oyster is always referred to by number, it is plain that it is undergoing changes day by day, hence to this num-

ber is appended in the experiments a designation, stating the number of days the oyster has been in the hands of the operator, divided into two parts, the first (for-open) showing what day it was opened, and the second (aft-open), what day after opening it was used. Thus, 0+1 indicates an oyster opened the day of its reception, and used one day later. It is twenty-four hours' old when used, hence its age is one day, as indicated by the sum of the numbers. Similarly 5+2 represents an oyster a week old, which was opened the sixth day (inclusive), and the third day (inclusive) thereafter, was used for experiment.

OPENING THE OYSTERS.

Each oyster was opened by cutting the adductor muscle at its right end, leaving the oyster attached to and lying upon its left (deeper) shell, that there may be no draining away of its juices. The right valve may be used as a cover, although in a majority of the cases reported in this article, this was discarded. The oyster dies gradually; its heart may beat for several hours, and the tissues survive the general death or cessation of physiological co-ordination. The tissues do not die and begin decomposition synchronously; the male gametes are the last to yield.

TAKING SPAWN.

To perform a fertilization experiment a mixture of the milky spawn from the two sexes must be infused into sea-water. The spawn may be gotten out of the gonad by several methods. Brooks's method is to cut up the gonad with scissors, in the water, and to pick out the shreds of tissue with forceps, and wash the eggs to get rid of finer debris, by the method of decantation; the eggs being heavy they settle rapidly, and allow the supernatant fluid containing impurities, spermatozoa and the like, to be poured off. Ryder's method is to stroke the oyster's reproductive gland gently in the direction of the openings of the oviducts, as is done in fish propagation. This has the advantage of cleanliness, but not so many eggs are secured, although most of those obtained may be considered ripe. Our own methods are various, and adapted to securing the microscopic amounts used. To simply examine the spawn (to see if it is male or female), the medicine dropper is thrust through the gonadial or body wall,

until the spawn can be sucked up. To use all the contents of the gonad (unripe eggs and all), we peel off the external membrane covering the sexual glands and then mash the substance of the gland with forceps until a uniform pulp or "lymph" is formed, which can be sucked up in definite amounts in the dropper, which may be calibrated for this purpose. This method (or modifications of it) was used in the majority of instances when a considerable number of eggs was desired.

EGG CHARACTERS.

The eggs appear, when magnified, as club-shaped, translucent bodies of uniform size, if the majority are ripe. But in cases "not good," "not ripe," etc., the eggs may show up more or less irregular in shape and size, or be rounded, swollen, decomposing or "vesicular." The last condition is presented by eggs whose contents have shrunk or dissolved while the egg membrane has swollen, leaving clear spaces at the periphery. There are often many "granules" present besides the eggs, or the eggs may show granules within. Eggs that "go to the bad" in solution, become "opaque," "granular," "swell," "round up" and finally decompose or become "vesicular." In "good" cases (especially if fertilized) the eggs simply become spherical.

THE SPERMATOZOA.

If the spermatozoa be examined in their own lymph they appear as an opaque fluid of very fine granules; either the granules are passive or they are actively swarming. If passive, it often suffices to add a little sea-water, when the spermatozoa are at once stimulated to activity. But sometimes a "latent period" of some minutes elapses, and the spermatozoa acquire motion gradually. When highly magnified, a long, slender "tail" is seen attached to each granule, the lashings of which, from side to side, cause the motion of the granule or "head." Each spermatozoon is not in continuous movement, but starts up, gives a few twitches of its tail and settles down in a new position, much as tadpoles do in their native pools. This motion is termed the "tadpole" movement. As the activity of these sperm animalcules increases the periods of rest become so short as scarcely to be noticed, except very few spermatozoa are present in the field of

view. The motion of a large mass appears like the swarming of a cloud of May-flies, or *ephemerides*, wherefore we have termed this phase of motion the "ephemeris stage." Later, as the spermatozoa become weaker, the stages are passed through in the inverse order. In certain solutions there is a peculiar trembling of the tail which may be designated by the term "shivering."

DEVELOPMENTAL STAGES.

When ripe eggs are properly fertilized by admixture with the male milt, each egg receives but one spermatozoon, and then begins to assume a rounded shape, which, when completed, constitutes the first stage of development. During the second stage two small globules are given off from one point of the egg, which point is now termed the "animal pole." These globules are "polar globules." Then the egg elongates and the material at the animal pole rounds up like a smaller egg perched upon the remaining portion of the egg which forms a similar but larger sphere below, known as a "macromere;" while the smaller sphere above is the "micromere. In succeeding stages the micromere continues to split up into smaller micromeres, and the macromere also divides, but at a much slower rate. The micromeres at last constitute a cap (the blastoderm) upon the macromere and gradually envelop it, the uncovered pole being termed at this stage "the blastopore." When the macromere (or macromeres) are entirely surrounded by the smaller cells, the embryo is called a "gastrula." The next change is the acquiring of hair-like appendages (*cilia*) by the outer cells. These are movable, and lash the water vigorously enough to cause the embryo to rotate and finally to swim rapidly. Then the little oyster no longer lies upon the bottom, but seeks the surface, where it can secure more air needed for such rapid locomotion. Meanwhile a space appears between the internal cells (macromeres), which grows larger as the cells multiply, and finally becomes a stomach, which is later put into communication with the outside by means of a mouth and an intestine. The cells surrounding the stomach become liver cells that give a more opaque appearance to the center of the embryo. Lastly, the shell appears as a pair of small dark "valves" upon the sides of two flaps, the "mantle lobes," at the point where the future hinge or "beak" is to be. The shell is a secretion, and appears to be preceded or produced by a glandular

structure known as the "shell gland." But there are obscure points regarding this stage, and these structures need further study. A study of the embryology of the oyster did not engage our attention, and we are indebted to the work of Dr. W. K. Brooks, of Johns Hopkins University, Baltimore, for what knowledge we have of the oyster's life history up to this point. Other observers have added here and there, notably Professor John A. Ryder, of Philadelphia (University of Pennsylvania), and the lamented Professor Rice, who worked in New York and Cold Spring Harbor. But the gaps in our knowledge are numerous. In our work last summer we took no special care of the embryos, and they mostly succumbed to infusoria in a few days, about the time of the appearance of the shell. Referring to the figures of oyster development, as observed by Brooks and copied by Ernest Ingersoll in his great monograph on the "Oyster Industry in the United States," we have designated the following stages as easily recognizable by any observer, and serving useful purposes in tracing the rate of development. (See Brooks's plates, Ingersoll's report):

Stage I. Fertilization to rounding.
" II. Extrusion of polar globules (Figs. 1–4).
" III. Two micromeres and one macromere (Figs. 5–9).
" IV. One micromere has re-united with the macromere (Figs. 10–15).
" V. Four micromeres and one macromere (Figs. 16, 17).
" VI. One micromere has re-united to the macromere (Figs. 18, 19).
" VII. Five micromeres and one macromere (Figs. 20, 21).
" VIII. Seven micromeres and one macromere (Fig. 22).
" IX. Twelve micromeres, or first "blastoderm" stage (Fig. 23).
" X. Second blastoderm stage; macromere half enveloped (Figs. 24, 25).
" XI. First gastrula stage; blastopore closed by one macromere (Fig. 26).
" XII. Second gastrula stage; blastopore nearly obliterated, embryo elongating and acquiring *cilia* (Figs. 27–30).
" XIII. First motile (larval) stage (Fig. 32).
" XIV. Second motile (larval) stage; stomach and liver outlined (Fig. 36).

Later stages, showing shell and the fixation of the embryo to form the "spat" or "set," were not observed in our experiments.

SORTING EGGS (STRATIFICATION).

The various kinds of debris or dirt, eggs, etc., present in a solution, settle with different degrees of rapidity, and this fact can, to some extent, be taken advantage of in separating valuable from deleterious material. It takes the more solid eggs about five or six minutes to drop an inch in ordinary sea-water. The material that settles during the first minute or two, if a dish or graduate be not too deep, will be comparatively free from lighter matters, and is termed in the experiments, "first bottom," one-minute bottom (or settlings), etc. "Early bottom" constitutes the fall of the first five minutes. "Late bottom," the settlings of all the heavier material of a four-inch or three-inch-deep jar for about fifteen minutes. "Last bottom" is the residue precipitated inside of half an hour, which we usually stirred up with the supernatant liquid after the top strata are removed, and termed "middle." Similarly we have "first top," "early top," "late top" and "last top" or "middle," as above. In general practice we used most frequently "5-minute bottom," "5-minute top," and "residue," or "middle," as sufficient for our purposes.

There is another method of sorting applicable to microscopic samples. If two cubic centimeters of infusion are put in a solid watch-glass, and the glass is rapidly shoved or shaken back and forth, the heavier and lighter materials are "sifted" apart and can be sucked up, each sort by itself, with a dropper. This method is termed sorting by "shaking," as distinguished from the above "stratifying" process. As regards the segmented eggs, these may be normal, as in the above "stages," or be "pathological" where there is gross departure from the rule and grotesque shapes assumed, due to imperfect maturity, or more probably, to super-fecundation, as when several spermatozoa succeed in entering an egg. But this is because the egg lacks power to react with sufficient vigor to shut out late-comers. So, also, may result pathological embryos; and many of these may result from an impure or unfavorable condition of their surroundings, as when they are decomposing. Finally we use the terms "bottom embryos" and "top embryos" to designate respectively the slightly-active or rotating gastrulas lying at the bottom, and the active larvæ that swim or are capable of swimming at the surface.

Now follows the record of data, after which we discuss the bearings of these upon the preceding questions.

§ 6. *Tables of Oysters Used in Experiments.*

TABLE I.—Oysters Used in Experiments (First Set).

ABBREVIATIONS.

H. R. = Hudson river; N. B. = Newark bay; E. R. = East river; D. R. = Delaware river; R. R. = Raritan river; V. = Virginia; O. = Oceanic; Kt. = Keyport; P. A. = Perth Amboy; gms. = grams; f. = female; m. = male; —— = no observation; p. = preserved; sp. = spermatozoa; cytohel. = cytohelminths.

Number.	Date when removed from planted bed.	Bed whence seed obtained.	Where planted.	Weight with shell—grams.	When opened.	Sex.	Character of germ cells.		Parasites.	Histological preparation-mark.	General remarks.
1	June 19.	H. R.	O.	——	June 20, 4.00 P. M.	f.	Ripe.		——	*1	
2	"	N. B.	"	——	" "	f.	Not ripe	[illegible]	....	2	
3	"	E. R.	"	——	" "	m.	"	——	——	3	
4	"	D. R.	"	——	" "	m.	Ripe.	Ducts outlined.	....	4	
5	"	H. R.	"	——	June 21, 5:00 P. M.	f.	Eggs round.	....	——	1	Eggs imbedded in granules.
6	"	N. B.	"	——	" "	m.	Ripe.		——	——	
7	"	E. R.	"	——	" "	f.		——	——	3	
8	"	D. R.	"	——	" "	f.	[illegible]	....	——	4	
9	June 26.	H. R.	"	——	June 27, 4:30 P. M.	f.	[illegible]	....	Cytohel.	1	
10	"	H. R.	"	105.8	" "	m.	[illegible]	....	"	1	
11	"	H. R.	"	117.8	" "	f.	[illegible] granules present	....	"	1	
12	"	N. B.	"	88.0	" "	m.	Ripe.	Ducts outlined.	"	——	Intestine crowded with cytohel.
13	"	N. B.	"	125.7	June 30, 3:00 P. M.	m.	"	" "	No parasites.	——	
14	"	E. R.	"	117.2	" "	m.	"	Poor and dark.	Cytohel.	6	
15	"	E. R.	"	101.0	" "	f.	Eggs degenerated.	....	——	7	
16	"	D. R.	"	85.5	July 2, 4:40 P. M.	m.	Ripe, frothy, viscid.	Ducts outlined.	——	p.	
17	"	D. R.	"	98.0	" 5:45 P. M.	f.	Ripe; soft.	Uniform.	——	p.	Had lost a piece of its nib and its juices had drained away.

*These figures refer to the number on vial that contains the sample.

NOTE.—Nos. 1 to 8 received from C. T. Allen, Oceanic, per express, June 20; Nos. 9 to 17, June 27.

TABLE I.—Oysters Used in Experiments (First Set).—Continued.

Number.	Date when removed from planted beds.	Bed whence seed obtained.	Where planted.	Weight with shell—grams.	When opened.	Sex.	Character of germ cells.	Remarks on oyster's condition or appearance.	Parasites.	Histological preparation-mark.	General remarks.
18	July 2.	R. R.	P. A.	114.0	July 3, 3:20 P. M.	m.	Ripe.	Green; ducts outlined.	—	*1	Heavy-shelled cullens from mud-banks near Capt. Noe's dock.
19	"	R. R.	"	114.0	" 3:45 P. M.	m.	Ripe.	Dark; uniform.	—	2	
20	July 1.	V.	Kt.	245.0	" 4:12 P. M.	f.	Eggs shrunken.	Gonad uniform.	—	3	Nacre of shell numerously spotted with small, round dark spots. Oyster dark and watery.
21	"	V.	"	124.0	" 4:20 P. M.	m.	Ripe.	Uniform.	—	3	
22	"	V.	"	75.0	" 4:30 P. M.	m.	"	....	—	4	
23	"	V.	"	100.0	" 4:40 P. M.	f.	Eggs represented by fragments as if spawned	....	—	4	Oyster dark and watery; poor.
24	"	V.	"	—	July 5, A. M.	f.	....	....	—	2	Died in sea-salt solution, 2½ per cent. (Expt. 27.)
25	"	V.	"	—	July 5, P. M.	m.	Sp. feeble.	....	....	2	Died in [illegible]lution, 2½ per cent.
26	July 2.	R. R.	P. A.	—	—	—	—	—	—	2	Kept in [illegible]nt. sea-water. (See E[illegible])
27	July 1.	V.	Kt.	—	July 5, noon.	m.	Sp. active.	—	—	—	Kept dry; died before opening.

* These figures refer to the number on vial that contains the sample.

NOTE.—Nos. 18 and 19 received from J. E. Noe, Perth Amboy. Nos. 20 to 25 received from Joseph Aumack. No. 26 received from Capt. Noe. No. 27 received from J. Aumack, Keyport.

TABLE II.—Oysters Used in Experiments (Second Set).

ABBREVIATIONS.

H. R.—Hudson river; N. B.—Newark bay; E. R.—East river; D. R.—Delaware river; O.—Oceanic; S. H.—Sandy Hook; f.—female; m.—male; sp.—spermatozoa; cytohel.—cytohelminths.

Number.	Date of removal from planted bed.	Bed whence seed obtained.	Where planted.	Number of specimens.	When opened.	Sex.	Character of germ cells, oyster, &c.	Parasites present.	Mark of specimens when preserved.	Furnished by
28	July 7.	D. R.	O.	2	July 7, 12:00 M.	f.	Ripe.	*Cytohel.	....	C. T. Allen, from planted beds near Laboratory.
29	"	H. R.	"	4	" "	m.	....	"	....	" " " " "
30	"	N. B.	"	5	" "	m.	....	"	....	" " " " "
31	"	E. R.	"	?	" "	m.	....	....	....	" " " " "
32	"	S. H.	"	?	" "	m.	....	....	....	" " " " "
33	"	D. R.	"	3	" 2:30 P. M.	m.	....	....	....	" " " " "
34	"	E. R.	"	2	" 4:00 P. M.	f.	....	....	....	" " " " "
35	"	E. R.	"	3	" "	m.	....	....	....	" " " " "
36	"	D. R.	"	2	" 4:15 P. M.	f.	....	....	....	" " " " "
37	"	D. R.	"	?	" "	m.	....	....	....	" " " " "
38	"	P. B.	"	1	" 5:45 P. M.	f.	Ripe; good.	....	....	" " " " "
39	"	N. B.	"	1	" 7:00 P. M.	f.	Spawned.	....	1	" " " " "
40	July 8.	?	"	2	July 9, 7:00 A. M.	f.	....	....	....	" " " " "
41	"	?	"	2	" "	m.	Sp. not active at once.	....	....	" " " " "

*Cytohelminths imbedded in a lumbricoidal-shaped mass of jelly in a loop of intestine.

TABLE III.—Oysters Used in Experiments (Third Set).

ABBREVIATIONS.

H. R. — Hudson river; N. B. — Newark bay; E. R. — East river; D R. — Delaware river; R. R. — Raritan river; V. — Virginia; O. — Oceanic; Kt. — Keyport; P. A. — Perth Amboy; f. — female; m. — male; —— — no observation; S. H. — Sandy Hook; sp. — spermatozoa; cytohel. — cytohelminths.

Number.	Date of removal from planted beds.	Bed whence seed obtained.	Where planted.	Number of specimens.	When opened.	Sex.	Character of germ cells, oysters, &c.	Parasites present.	Mark of specimen preserved.	Obtained from.	General remarks.
40a	July 8, 7:00 A. M.	S. H.	O.	1	July 10, 5:00 P. M	f.	Ripe.				Transported from Oceanic to Keyport.
41a	〃 〃	〃	〃	1	〃 〃	m.	〃				〃 〃 〃
42	July 10, 7:00 A. M.	E. R.	Kt.	2	〃 3:30 P. M.	m.	Ripe; sp. not active at once.			Capt. J. Bedle.	
43	〃 〃	〃	〃	3	〃 〃	f.	Spawned.			〃	
44	〃 〃	〃	〃	3	〃 〃	f.	Ripe.			〃	
45	〃 〃	〃	〃	2	〃 〃	f.	Nearly ripe.				
46	July 11, 7:00 A. M.	V.	〃	2	July 11, 2:00 P. M.	f.	Ripe.			Restaurant.	Had been planted at Keyport for two months and freshened for market.
47	〃 〃	〃	〃	1	〃 〃	m.	〃			〃	
48	July 10, 7:00 A. M.	E. R.	〃	1	July 12, 3:00 P. M.	f.	〃			Capt. Bedle.	
49	〃 〃	〃	〃	1	〃 〃	m.	〃			〃	
50	〃 〃	〃	〃	2	〃 〃	f.	Fairly good.			〃	
51	〃 〃	〃	〃	1	〃 〃	m.	—	Cytohel.		〃	
52	〃 〃	〃	〃	2	〃 〃	m.	Poor.			〃	
53	July 14, 7:00 A. M.	V.	〃	1	July 14, 4:00 P. M.	m.	—	—	—	Restaurant, as per 46.	Had f. Pinnotheres as commensal.
54	〃 〃	〃	〃	2	〃 〃	m.	—			Restaurant, as per 46.	
55	〃 〃	〃	〃	1	〃 〃	f.	Eggs imbedded in granules.		1	Restaurant, as per 46.	
56	〃 〃	〃	〃	1	〃 〃	m.	—		3	Capt. Bedle.	Two-year plants; had f. Pinnotheres as commensal.
57	〃 〃	〃	〃	2	〃 〃	f.	Eggs vesicular, imbedded in granules.	—	3	〃	
58	〃 〃	〃	〃	1	〃 〃	f.	Like 57.	Cytohel.		〃	
59	July 10, 7:00 A. M.	E. R.	〃	1	July 15, 9:00 A. M	f.		—	—	〃	Gaping July 14, but shut when tapped; July 15, failed to shut.
60	〃 〃	〃	〃	1	〃 〃	f.		—	—	〃	Gaping July 14, but shut when tapped; July 15, failed to shut.
61	〃 〃	〃	〃	2	〃 〃	m.		—	—	〃	Not gaping.
62	〃 〃	〃	〃	1	〃 〃	f.		—	—	〃	〃 〃

TABLE III.—Oysters Used in Experiments (Third Set)—Continued.

Number.	Date of removal from planted beds.	Bed whence seed obtained.	Where planted	Number of specimens.	When opened.	Sex.	Character of germ cells, oysters, &c.	Parasites present.		from.	General remarks.
63	July 14, 7:00 A. M.	V.	Kt.	2	July 15, 10:30 A. M.	f. ?	Fat, milky (granules).	....		ʒedle.	F. Pinnotheres present as commensal. Gonadial fluid composed of granules, not motile; no eggs present.
64	" "	"	"	1	" "	f.	Eggs and granules.	....			
65	" "	"	"	1	July 16, 2:30 P. M.	f.	——	....			Shell open
66	" "	"	"	2	" "	......	Spawned.	....			
67	July 19, 7:00 A. M.	"	"	1	July 19, 12:00 M.	m.	....	....			Two and one-year plants.
68	" "	"	"	1	" "	f.	Ripe.	....			" " "
69	" "	"	"	1	" "	f.	....	....			" " "
70	" "	"	"	6	" "	f.	....	....			" " "
71	July 22, 7:00 A. M.	"	"	8	July 22, 2:00 P. M.	m.	....	....			Last year plants.
72	" "	"	"	1	" "	f.	Nearly spawned.	....			" "
73	" "	"	"	4	" "	m.	Sp. not active at once.	....			This year plants. See Obs. 18, July 23.
74	" "	"	"	4	" "	f.	Some poor; others fair.	....			" " " " " " " "
75	July 29, 7:00 A. M.	R. R.	P. A.	1	July 30, 2:00 P. M.	m.	Ripe.	....		), P. A	
76	" "	"	"	9	" "	s.	Spawned.	....		"	
77	July 30, 7:00 A. M.	V.	Kt.	2	" "	m.	Ripe.	....		ʼant.	Four months' plants, freshened—gaping.
78	" "	"	"	1	" "	f.	"	....			" " " " "
79	" "	"	"	1	" "	f.	Ripe; good.	....			Had lain lowermost in cluster, with attached male above.
80	" "	"	"	1	" "	f.	Eggs and granules.	....			Had lain lowermost in cluster, with attached male above.
81	" "	"	"	3	" "	m.	Ripe.	....			[illegible] with
82	" "	"	"	1	" "	m.	"	....		ʒedle.	Two-year plants; Rappahannocks.
83	" "	"	"	1	" "	m.	Granular.	....	......		" " "
84	" "	"	"	4	" "	f.	Vesicular eggs & gran's	Cytohel.	......	"	" " "
85	July 29, 7:00 A. M.	R. R.	P. A.	1	Aug. 2, 10:00 A. M.	m.	Ripe.	....	......	Capt. Noe.	
86	" "	"	"	14	" "	s.	Spawned.	....	......	"	
87	" "	"	"	7	....	......	....	....	......	"	Put in water August 2. (See Expt. 89.)
88	Aug. 7, 9:00 A. M.	E. R.	O.	8	....	......	....	....	......	C. T. Allen, O.	Put in water August 8. (See Expt. 90.)
89	" "	"	"	4	Aug. 8, 10:00 A. M.	s.	Spawned.	....	......	" "	
90	" "	N. B.	"	4	....	......	....	....	......	" "	" " " " "
91	" "	"	"	6	Aug. 8, 10:00 A. M.	s.	No spawn present.	....	......	" "	

§ 7. *Calendar.*

The temperature recorded is that of the air in the Laboratory.

TABLE V.

New Brunswick Experiments (First Set).

Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.	Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.
June 20...	Fr.	4:00 P. M.	70	1–4		July 1...	Tu.	3:30 P. M.	77	18–21	3
" 21...	Sat.			5–9		" 2...	W.	4:00 P. M.	75	22–27	4
" 27...	Fr.	3:00 P. M.	74	10		" 3...	Th.	12:00 M.	74	28–34	5–7
" 28...	Sat.	10:45 A. M.	74	11–13	1	" 5...	Sat.	11:00 A. M.	75		8, 9
" 30...	M.	3:00 P. M.	75	14–17	2						

Oceanic Experiments (Second Set).

Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.	Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.
July 7...	M.	12:00 M.	82	35–37½	10	July 8...	Tu.	12:30 P. M.	92		
		5:30 P. M.	81					3:00 P. M.	93		
" 8...	Tu.	6:15 A. M.	72	37*a*–44				7:45 P. M.	83		
		8:30 A. M.	79			July 9...	W.	6:30 A. M.	80	45–76	11
		9:30 A. M.	82								
		10:30 A. M.	85								
		12:00 M.	90								

Keyport Experiments (Third Set).

Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.	Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.
July 10...	Th.	7:00 A. M.	60	47, 48	12, 13	July 16...	W.	1:00 P. M.	86	74–77	
		3:00 P. M.	72					3:00 P. M.	88		
" 11...	Fr.	10:00 A. M.	70	49–56		" 19...	Sat.	11:00 A. M.	73	78	
		1:00 P. M.	74					2:00 P. M.	76		
		4:00 P. M.	76			" 21...	M.	2:30 P. M.	74	79–82	17
" 12...	Sat.	11:30 A. M.	74	57–59				5:30 P. M.	74		
		2:15 P. M.	78			" 22...	Tu.	8:00 A. M.	65	83	
" 14...	M.	12:45 P. M.	72	60–65	14, 15			2:45 P. M.	76		
		2:30 P. M.	74			" 23...	W.	1:00 P. M.	74		18
		4:30 P. M.	76			" 24...	Th.	2:00 P. M.	78	84, 85	19, 20
		6:25 P. M.	76			" 25...	Fr.	1:00 P. M.	77	86	21
" 15...	Tu.	8:00 A. M.	74	66–73	16	" 29...	Tu.				22
		10:45 A. M.	79			" 30...	W.	1:00 P. M.	83		23
		1:00 P. M.	82					3:45 P. M.	86		
		2:15 P. M.	84								

New Brunswick Experiments (Fourth Set).

Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.	Day of month.	Day of week.	Hour.	Temperature, degrees Fahr.	Experiments.	Observations.
July 31...	Th.	8:30 A. M.	88	87, 88	24	Aug. 8...	Sat.			90	
Aug. 2...	Sat.	5:00 P. M.	70	89	26	" 10...	M.	12:00 M.	72		25

§ 8. *Record of Experiments with the Germ-Cells of the Oyster.*

ABBREVIATIONS.

Expt.—experiment; obs.—observations; sp.—spermatozoa;
No.—the number of the oyster as in tables; cc.—cubic centimeter.
See, further, the explanations given on pp. 256, 257.

First Set.

NEW BRUNSWICK EXPERIMENTS.

June 20th, Friday.

Expt. 1, at 4:30 P. M. Sp. of No. 4 [1 + 0] infused into one per cent. salt solution. At 6 P. M. sp. still motile.

Expt. 2, at 4:45. First expt. repeated. Still motion at 6 P. M.

Expt. 3, at 4:45. Sp. of No. 4 [1 + 0] infused into hydrant-water. Sp. cease moving at once. Motion not resumed.

Expt. 4, at 4:45. Fertilized eggs of No. 1 [1 + 0] with sp. of No. 4 [1 + 0] in one per cent. salt solution. At 6 P. M. no segmentation begun.

June 21st, Saturday.

Obs. of Expt. 4, at 10:30 A. M. A number of rotating embryos with motion in direction of hands of watch present.

Expt. 5. Eggs of No. 1 [1 + 1] infused into five per cent. salt solution become shrunken and very irregular.

Expt. 6. Eggs from No. 1 [1 + 1] infused into hydrant-water assume a spherical form and swell perceptibly.

Expt. 7. Sp. in five per cent. salt solution lose motility at once. Loss of motion permanent.

Expt. 8. Sp. in three per cent. salt solution suffer a great slowing of motion for all, and loss of motion of the great majority.

Expt. 9. Sp. infused into a series of salt solutions differing by one-quarter of a per cent. from three per cent. to zero per cent., and the result showed that a solution weaker than one-fourth per cent. causes immediate loss of motion to spermatozoa of the oyster.

June 27th, Friday.

Expt. 10. Cytohelminths of Nos. 9 to 12 [1 + 0] infused into five per cent. salt solution die gradually, with worm-like contortions.

June 28th, Saturday.

Expt. 11, at 10:45 A. M. Sp. of No. 12 [1 + 1] infused into a series of percentage salt solutions as follows:

2½ per cent.—At 11:20, some live sp. remain; at 12:25, all quiet.
2 " 11:15, many lively sp. seen; at 12:25, all quiet.
1½ " 11:10, as for 2 per cent.
1 " 11:07, sp. have lost so much motion that the movements of cytohelminths interfere with the observation.
¾ " 11:00, motility of sp. about ceased.
½ " 10:55, as for ¾ per cent.
¼ " 10:50, as for ¾ per cent.

Expt. 12, at 11:35. Sp. in three-quarters of one per cent. salt solution; at 11:45, motion of sp. lively; at 12:15, ceased.

Expt. 13, at 11:40. Sp. of No. 12 [1 + 1] in one per cent. salt solution. Motion ceased at 12:15.

Obs. 1. Sp. of No. 12 [1 + 1] at 12:30 very active.

June 30th, Monday.

Obs. 2, at 3:00 P. M. Sp. of No. 12 [1 + 3] nearly all killed by putrefaction and drying of oyster.

Expt. 14. Sp. of No. 14 [4 + 0] infused into one-quarter of one per cent. and one-eighth of one per cent. solutions of calcic sulphate lose motion at once.

Expt. 15. Sp. of No. 14 [4 0] infused into three-quarters of one per cent., one and one-half per cent. and three per cent. solutions of magnesium sulphate lose motion at once.

Expt. 16. Sp. of No. 14 [4 + 0] infused into "sea-salt" solutions as follows:

3	per cent.—At	5:35 P. M.	At 5:55, still lively; at 6:06, a few retain motion.
2½	"	3:53 "	6:10, some motion still visible.
1¾	"	3:55 "	6:10, very active.
1¼	"	3:57 "	5:25, nearly all active; at 6:10, a few active.
1	"	4:00 "	5:25, nearly all active; at 6:10, a few active.
½	"	4:05 "	5:25, a few active; at 6:06, motion practically ceased.

Expt. 17. Sp. infused into stale sea-water (*i. e.* such as had been transferred from Raritan bay to New Brunswick a year ago and kept in close jars, where it had undergone fermentation) lose motion at once.

July 1st, Tuesday.

Obs. 3. Sp. in Nos. 13 and 14 [4 + 1] still active.

Expt. 18, at 4:10 P. M. Sp. of Nos. 13 and 14 [4 + 1] infused into "sea-salt" solutions at 90° Fah. of following percentages:

2½	per cent.—	Sp. show ephemeris movement at 4:35; nearly quiet at 4:40.
1¾	"	Sp. show tadpole movement at 4:27; quiet at 4:35.
1¼	"	Sp. show tadpole movement at 4:20; quiet at 4:25.
1	"	Sp. have all quieted at 4:20.
¾	"	Stocked at 4:15, sp. show traces of motion at 4:20.

In weaker solutions sp. are quickly quieted.

Expt. 19, at 4:50 P. M. Sp. of Nos. 13 and 14 [4 + 1] infused in large amount into a small amount of one and one-quarter per cent. "sea-salt" solution at 77° Fah. At 5:40 the motion becomes a jerky one, with little direct progress.

Expt. 20. Sp. in two and one-half per cent. "sea-salt" solution at 110° Fah. live a few minutes; slow up rapidly.

Expt. 21. Sp. in two and one-half per cent. "sea-salt" solution at 100° Fah. are very active for a time; are smaller than normal. In the weak solutions there is swelling.

July 2d, Wednesday.

Obs. 4. Sp. of Nos. 13 and 14 [4 + 2] show but little activity when first infused, but are stimulated into activity by a few minutes' stay in the solution; but this activity is short-lived.

Expt. 22, at 4:15. Sp. of Nos. 13 and 14 [4 + 2] infused into "sea-salt" solutions of low percentage strengths fail to become active. In—

1¼ per cent.—Sp. lose motion at 4:30.

2½ " Sp. acquire tadpole movement at 4:19.

Expt. 23. Sp. of No. 16 [6 + 0] infused into artificial sea-water solutions as follows:

¾	per cent.—At	4:48	P. M.,	sp. immediately motionless.
1	"	4:50	"	sp. immediately motionless.
1¼	"	4:50	"	sp. show a few active at 4:55; dead at 5:06.
1⅔	"	4:50	"	sp. show many active at 4:55; lively at 6:12.
2½	"	4:48	"	sp. very active at 5:04; lively at 6:12.
3	"	5:14	"	sp. active at 6:12.
3⅓	"	4:48	"	sp. active at 5:12; active at 6:12.
3¾	"	5:17	"	sp. dead at 5:35.
4	"	5:30	"	sp. show shivering stage at 5:50, 6:12 and 6:40.
5	"	5:30	"	sp. show shivering stage at once.

Expt. 24, eggs of No. 17 [6 + 0] infused into hydrant-water become first opaque and irregular, then granular, and finally vesicular by absorption of water between the yelk and the egg membrane.

Expt. 25, at 5:50 P. M. Eggs of No. 17 [6 + 0] infused into artificial sea-water of following strengths:

2½ per cent.—Eggs grow darker, shape unaltered.

5 " Eggs become granular, shrink and attain a very irregular shape.

Expt. 26, at 5:50. Eggs of No. 17 [6 + 0] fertilized with sp. of No. 16 [6 + 0] in two and one-half per cent. artificial sea-water. Eggs change shape and become more spherical; some more so than others.

Expt. 27, at 6:40. Placed Nos. 24, 25 [1 + 0] and 26 [0 + 0] in two per cent. artificial sea-water in glass dishes exposing a large surface relative to depth of water. One dish to each oyster. At 11:00 A. M., July 5th, No. 24 [4 + 0] dead (gaping); No. 25 [4 + 0] shuts slowly when tapped; died in afternoon; No. 26 [3 + 0] stays shut. Water swarms with ciliated infusoria.

July 3d, Thursday.

Obs. 5, at 12:00 noon. Sp. of No. 16 [6 + 1] are very active, but show a swollen head (?) with a few prominent granules in it, and a long tail; undecided as to the nature of this "head," which may be simply a remnant of the spermatocyte organization.

Obs. 5½. Infusoria have invaded or developed in the three per cent. solutions of Expt. 23. They were not identified, are shaped like an exclamation point and swim in a tadpole manner.

Expt. 28, at 1:00 P. M. Sp. of No. 16 [6 + 1] infused into artificial sea-

water of one and two-thirds per cent., two and one-half per cent., three and one-third per cent., dead at 3:00.

Expt. 29, at 3:20. Sp. of No. 16 [6 + 1] infused into artificial sea-water as follows:

1⅔ per cent.—Sp. are quiet at 3:40.
2½ " Sp. have faint motion at 3:40; dead at 3:52.
3⅓ " Sp. have faint motion at 3:40; shivering at 3:52 and dead at 4:05.

Obs. 6, at 3:20. Sp. of No. 18 [1 + 0] not active when first infused, but become so after a while.

Obs. 7, at 3:45. Opened No. 19 [1 + 0]; its heart beats eight times per minute.

Expt. 30, at 3:20. Sp. of No. 18 [1 + 0] infused into two and one-half per cent. artificial sea-water, not active at once; attain a jerky motion at 3:40; very active at 3:50; still active at 4:07.

Expt. 31, at 3:50. Sp. of No. 19 [1 + 0] infused into two and one-half per cent. artificial sea-water, active at once; a few still active at 4:07.

Expt. 32, at 4:15. Eggs of No. 20 [2 + 0] fertilized with sp. of No. 18 [1 + 0] in artificial sea-water as follows (covered by bell-glass):

3⅓ per cent.—Obs. at 11:00 A. M., July 5th, shows a few embryos and no infusoria.
2½ " Obs. at 11:00 A. M., July 5th, shows no embryos, no infusoria.
1⅔ " Obs. at 11:00 A. M., July 5th, shows many embryos, no infusoria.

Expt. 33, at 4:25. Sp. of No. 21 [2 + 0] infused into two and one-half per cent. artificial sea-water show a few active at once and increase of activity at 4:30.

Expt. 34, at 4:40. Eggs of No. 23 [2 + 0] fertilized by sp. of No. 22 [2 + 0] in two and one-half per cent. artificial sea-water, and covered; observed at 11:00 A. M., July 5th, show some embryos and numerous ciliated infusoria like those noted in Expt. 27.

July 5th, Saturday.

Obs. 8. No. 27 [4 + 0] at 12 noon found gaping, but shuts when tapped; contains lively sp.

Obs. 9. No. 25 [4 + 0] of Expt. 27, when dead has sp. with some activity.

Second Set.

OCEANIC EXPERIMENTS.

July 7th, Monday.

Obs. 10. Several specimens of Nos. 28 [0 + 0] and 30 [0 + 0] possess the "crystalline rod," which is lodged in a loop of the intestine; in others this rod is soft and darker; in others it has given place to a dark, syrup-like fluid which is filled with cytohelminths.*

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*Described in § 10.

Expt. 35, at 2:30 P. M. Eggs of No. 28 [0+0] fertilized by sp. of Nos. 29 and 30 [0+0] (a mixture of germ cells of several oysters, as indicated by the fifth column of Table II.) in sea-water from Navesink (North Shrewsbury) river, about one and two-thirds per cent. strength.

One dish was placed in direct sunlight and attained a temperature of 100° Fah. Stage III. of segmentation was observed at 3:20. The cooler lot (82° Fah.) was transferred to a life-box at 3:35, the eggs being in stage VI. At 3:50 stage IX. was reached; at 4:45, stage XI.; at 5:35 stage XIII. (swimming stage) begun. At 6:30 the embryos were very active in the life-box. The embryos swim in direct lines, with polar globule ahead. In the main jar the development was slower.

At 9:00 A. M., July 8th, embryos in life-box are in stage XIV., and begin to settle, as if ready to fix themselves. No shell gland, or "shell rudiment," present. At 2:15 the embryos begin to decompose. Temperature, 96° Fah. At 7:45 the water begins to swarm with ciliated infusoria. Nearly all are decomposed. Some few remain in good condition, and one embryo was seen with rudiment of shell gland (?). Others continue swimming, even though much broken up. At 10:00 P. M. the last embryos of life-box have succumbed.

The embryos left in larger glass dish seem to pass through the same changes which were suffered by those in the life-box, but with less rapidity. At first swarming near the surface, they later (stratified July 8th, at 12:45) distributed themselves more uniformly throughout all depths (July 8th, noon). The infusoria gain headway, and by the morning of July 9th the embryos have all become decomposed. That some might have fixed themselves to the sides of the glass vessel could not be determined, owing to the dirt deposited by the decomposing embryos obscuring this observation.

Expt. 36, at 5:30 P. M. Eggs of Nos. 34 [0+0] and 36 [0+0] fertilized by sp. of 35 and 37. At 7:00 P. M. had reached stage III. Subsequent history like that in Expt. 35.

Expt. 37, at 7:00 P. M. Eggs of No. 38 [0+0] divided into seven lots in sea-water and fertilized as follows:

(*a*) in 1 minute.	(*e*) in 10 minutes.
(*b*) " 2½ "	(*f*) " 15 "
(*c*) " 5 "	(*g*) " 30 "
(*d*) " 7½ "	

In (*f*) and (*g*) the eggs assume the rounded form before fertilization. At 6:15 A. M., July 8th, all dishes (*a*–*g*) contain swimming embryos.

Expt. 37½, at 7:30 P. M. Eggs of Nos. 34, 36 and 38 [0+0] fertilized by sp. of Nos. 33, 35 and 37 in one dish. Next morning show fine motile embryos.

July 8th, Tuesday.

Expt. 37*a*, at 6:30 A. M. Stratified contents of dishes (*a*–*g*) of Expt. 37 and of 37½ in the graduate, with following result:

At 8:30 A. M. surface stratum contains numerous active oyster embryos in fine condition; the thickest, middle stratum contains dead sp. and granules from decomposed eggs and the gonad. The sediment on the bottom con-

sists of sluggish embryos rotating in a direction opposite that of the hands of a watch, and pathological and teratological embryos, unimpregnated and unsegmented eggs, rounded, irregular, and in various stages of decomposition, and lastly of unripe eggs and fragments of gonadial tissue. The embryos were taken off and placed in a dish of sea-water. Their subsequent history was similar to that of Expt. 35.

The lighter and irregular particles of dirt were separated from the more uniform eggs in the sediment of Expt. 37*a* by shaking.

Expt. 38, at 9:30. Sp. of No. 37 [0 + 1], etc., infused into sea-water to test viability.

At 12:30, sp. still active, but slower.

At 2:15, sp. dead.

Expt. 39, at 9:45 A. M. Introduced 1 cc. of spermatized sea-water below 4 cc. of clear sea-water in the graduate. The milky, introduced fluid is separated by a sharp line from the supernatant water.

At 10:15 A. M. the line of demarkation is still distinct.

Expt. 40, at 10:00 A. M. Eggs of No. 28 [0 + 1] were infused into sea-water and fertilized, after sojourn of various periods, as follows:

(*a*) At 10:30 A. M.

(*b*) At 11:00 A. M.

At 12:30 both lots in stage IX. of development.

Expt. 41, at 11:00 A. M. Introduced spermatized sea-water upon the surface of clear sea-water in graduate. Owing to greater specific gravity of the spermatized fluid, this drops in milky clouds to the bottom of graduate. The fluid was then diluted until its specific gravity permitted it to remain on the surface. It then formed a distinct stratum.

At 12:00 noon the line of demarkation was still distinct.

Expt. 42, at 2:35 P. M. Sp. of No. 37 [0 + 1], etc., infused into sea-water; at 7:00 P. M., dead.

Expt. 43, at 7:35 P. M. Stratified eggs of No. 38 [0 + 1] and fertilized all lots with sluggish sp. at 7:45 P. M.

(*a*) Top stratum after two minutes; at 6:30 A. M., July 9th, found no embryos and a small percentage of eggs that had rounded.

(*b*) Top stratum after four minutes.

(*c*) Middle stratum after two minutes; at 6:30 A. M., July 9th, found no embryos and about half of eggs rounded.

(*d*) Bottom sediment after one minute; at 6:30 A. M., July 9th, found all eggs rounded and a few embryos.

(*e*) Stirred and took sample at once; next morning found a large percentage of rounded eggs, but no embryos.

Expt. 44, at 8:00 P. M. All eggs of Nos. 28, 34, 36, 38 [0 + 1] mixed and fertilized by all sp. of Nos. 29, 30, 31, 32, 33, 35, 37 mixed.

Next morning all eggs decomposed; no evidences of fertilization.

July 9th, Wednesday.

Obs. 11. Sp. of No. 41 [1 + 0] not active until acted on by sea-water for some minutes.

Expt. 45, at 7:00 A. M. Sp. of No. 41 [1 + 0] added to dishes of eggs *a*, *b*, *c*, *d*, *e*, of Expt. 43. At 10:00 A. M. no evidences of fertilization.

Expt. 46, at 7:00 A. M. Eggs of No. 40 [1 + 0] fertilized with sp. of No. 41 [1 + 0]. At 10:00 A. M. no evidences of fertilization.

At 10:30 removed laboratory apparatus to Keyport, taking with me gonads of 41 and 40; also Nos. 40*a* and 41*a*.

Third Set.

KEYPORT EXPERIMENTS.

July 10th, Thursday.

Obs. 12, at 4:00 P. M. Gonads of Nos. 40 and 41 [1 + 1] kept in bottles show eggs opaque and granular, many being decomposed. The sp. were inactive, except in the centers of the largest lumps of tissue.

Expt. 47, at 5:00 P. M. Eggs of No. 40*a* [2 + 0] stratified in sea-water of two per cent. and sediment of first minute fertilized by active sp. of No. 41*a*. Next morning at 9:00 found a few eggs had started segmentation, but none reached stage XI.

Expt. 47½, at 5:00 P. M. Eggs of No. 40*a* [2 + 0] fertilized by sp. of No. 41*a* and stratified. At 5:15 a layer of sediment was discernible. The upper layers of this differ but little from the deeper ones, except that the more swollen eggs are above and the more shrunken ones below. In fifteen minutes all intact eggs have fallen four inches, leaving only lighter dirt in suspension above. The supernatant liquid was drawn off and the sediment diluted. After fifteen minutes, new deposit was treated likewise, repeated twice, and the observation made that a stratum with marked clearness, sharply deliminated below, and of gradually-increasing thickness, appeared above in less than a minute of time. The rate of growth in thickness of this stratum was found to be two inches in thirteen minutes. This stratum represents fluid clear of all eggs. The sediment in two per cent. sea-water was placed upon a three and one-third per cent. solution of artificial sea-water, but the eggs settled through this, and at 7:30 P. M. all the eggs had reached bottom. Next morning found the eggs of this lot were not so much segmented as those of Expt. 47.

Obs. 13. At 4:30 found heart of No. 44 [0 + 0] beating eight per minute.

Expt. 48, at 4:45 P. M. Eggs of No. 44 [0 + 0] fertilized in sea-water by sp. of No. 42 [0 + 0]; at 9:30 A. M., July 11th, developed into fine swimming embryos. The subsequent history of these was similar to that of Expt. 35. They were stratified and July 12th examined with following result:

(*a*) Top, good embryos, but slow; water clear.

(*b*) Middle stratum, a few weak embryos; some dirt.

(c) First settlings, five minutes; many round eggs; many monads; few embryos.

(d) Fifteen-minutes settlings; like (c), but fewer eggs.

July 14th all embryos of this expt. have disappeared.

July 11th, Friday.

Expt. 49. Determined the saltness of sea-water at Keyport to be about two per cent., by following method: Solutions of artificial sea-water of different percentage strengths were tinted with aniline ink, and the lighter solutions were introduced at the bottom of a graduate of sea-water until a solution was found of such strength that it would rise into the supernatant water. Such solution was ascertained to be one of two and one-half per cent.; then the stronger series of solutions were tested on top of the water in like manner, and the weakest of this series which first showed a tendency to settle into the water below was of one and two-thirds per cent. This method was adopted, as the hydrometer at hand was too insensitive to admit of so close reading. The specific gravity could have been more easily determined by weighing an accurately-ascertained volume. For this form of the experiment I had no adequate facilities immediately at hand. The Beaumé scale of the hydrometer gives 1013 as the equivalent strength. The Shrewsbury water is somewhat fresher, about 1011, but is considerably weaker than this at low tide.

Expt. 50, at 11:00 A. M. Stratified eggs of Nos. 44 and 45 [0+1] mixed, and at 11:30 fertilized by sp. of No. 42 [0+1].

(a) Settlings of one minute; at 2:45 examined and found none segmented, many eggs rounded, some unchanged and much dirt.

(b) Settlings of five minutes; at 2:45 examined and found like (a).

(c) Top stratum after five minutes; examined at 2:45, show no eggs and much dirt.

(d) Top stratum after fifteen minutes; at 2:45, like (c).

(e) Middle, consisting of sediment which falls after fifteen minutes and rest of liquid above; examined at 2:45, showed none segmented, many rounded eggs, many unchanged eggs and much debris.

Eggs may have lain too long in water, as shown by—

Expt. 51, at 12:00. Eggs of Nos. 44 and 45 [0+1] fertilized by sp. of No. 42 [0+1], and at 1:00 P. M. stratified:

(a) One-minute bottom; examined at 2:30, shows a few segmented eggs.

(b) Five-minutes bottom; at 2:30 shows much dirt and a few segmented eggs.

(c) Five-minutes top; at 2:30 shows no eggs.

(d) Fifteen-minutes top; at 2:30 shows no eggs.

Expt. 52, at 3:00 P. M. Stratified eggs of Nos. 44 and 45 [0+1] and fertilized five-minutes settlings by sp. of No. 42 [0+1] at 3:30. Examined July 12th, at 12:00, with negative results.

Expt. 53, at 3:00 P. M. Eggs of Nos. 44 and 45 [0 + 1] fertilized and at 3:30 stratified:

Examined five-minutes settlings July 12th, at 12:00, and found a few eggs had reached stage X. and stopped at this point of development.

Expt. 54, at 3:00 P. M. Eggs of Nos. 44 and 45 [0 + 1] sorted and best left fifteen minutes in sea-water, and at 3:15 fertilized by active sp. of No. 47 [0 + 0]. No further record of obs. From analogy with preceding expts., would expect results to be negative. See, also, next.

Expt. 55, at 3:45 P. M. Selected best five of Nos. 43, 44 [0 + 1] and 45 [0 + 1], putting eggs from each oyster into a separate bottle and fertilizing all by sp. of No. 47 [0 + 0]. At 12:00, July 12th, examined bottles as follows:

(*a*) Mostly dirt; no embryos.
(*b*) Many eggs intact, but few are partly segmented.
(*c*) Some eggs reach stage X., and more stopped in earlier stages.
(*d*) As with (*c*).
(*e*) Numerous partly-segmented eggs.

Expt. 56, at 4:00. Eggs of No. 46 [0 + 0] fertilized by sp. of No. 47 [0 + 0]. July 12th, at 11:30, found about two-thirds of eggs had segmented and formed active embryos; the remaining eggs had rounded. Of the embryos about half are defective. July 14th, at 1:00 P. M., the rounded eggs show no change. The embryos have to a large extent succumbed; the foremost are in stage XIV., but feeble. By Monday night the embryos are all dead.

July 12th, Saturday.

Expt. 57, at 12:30. Prepared solutions of artificial sea-water of different strengths, into which sp. of No. 47 [0 + 1] were infused.

1 per cent.—Sp. not active at once; never show much activity. Activity at its height in half an hour; at 2:45 slowing up observed.

2 per cent.—Sp. quite active at 1:00; still all lively at 2:45.
3 " Sp. very active at 1:00; slower at 2:45.
6 " Sp. feeble at 1:00 P. M. (?); "shivering."

Expt. 58, at 12:30. Prepared solutions of artificial sea-water of different strengths and infused eggs of No. 46 [0 + 1]. These were fertilized by sp. of No. 47, after various periods of sojourn. At 4:30 all lots were transferred to two per cent. sea-water.

1 per cent. fertilized in one minute; examined at 4:00 P. M. show a very few segmented to stage VIII.; no further progress.

1 per cent. fertilized in fifteen minutes; only a few found in stage III. at 4:00; no later progress.

1 per cent. fertilized in thirty minutes; same as last.

2 per cent. fertilized in one minute, show segmentation at 2:15 P. M., and at 4:00 P. M. have reached stage XI. (At 12:45, July 14th, this lot was badly decomposed.)

2 per cent. fertilized in fifteen minutes; have a similar history.

2 per cent. fertilized in thirty minutes; nearly as for preceding case.

3 per cent. fertilized in one minute; show no segmentation at 2:45; at 4:00 P. M. a few are in stage IX., and by Monday the lot is decomposed.

3 per cent. fertilized in thirty minutes; show a very pathological segmentation at 4:00; at 12:45, July 14th, a few rotating embryos and numerous monads found.

6 per cent. fertilized in fifteen minutes; no development.

Expt. 59, at 4:00 P. M. Eggs of No. 48 [2 + 0] fertilized with one-twentieth cc. of sp. of No. 49 [2 + 0] in one-half liter of sea-water. July 14th, at noon, many embryos found; most were pathological; still numerous at night. Next morning (July 15th) the infusoria had about eaten all up. Lot discarded at 3:00 P. M. Sediment prepared for histological examination [July 15th, No. 1].

July 14th, Monday.

Expt. 60, at 3:15 P. M. Eggs of No. 55 [0 + 0] fertilized by sp. of No. 54 [0 + 0]. At 4:30, sp. very active; still active at 6:30; at 6:30, eggs all decomposed.

Expt. 61, at 3:20 P. M. Sp. of No. 54 [0 + 0] infused into sea-water. At 4:30, sp. very active; at 6:30, still active; at 8:00, still active; at 9:00 P. M., dead.

Obs. 14, at 3:25. Sp. of No. 47 [0 + 3] still active. A few eggs of No. 46 [0 + 3] mostly broken up into granules. Prepared samples for histological purposes July 14th. These oysters are now mouldy or dried up, but the left side, resting in shell, is still moist, and from this the eggs and sp. were taken in following expt.

Expt. 62, at 3:30 P. M. Eggs from left side of No. 46 [0 + 3] fertilized by sp. left side of No. 47 [0 + 3]. At 4:30, sp. practically ceased moving. Eggs yield nothing but dirt on cleaning.

Expt. 63, at 3:45 P. M. Eggs of Nos. 48 and 50 [2 + 2] fertilized by sp. of Nos. 49 and 51 [2 + 2]. At 4:30, sp. ceased activity. Eggs, when cleaned, left only a few shrunken ones. At 6:25 P. M., some eggs in stage III. of development. At 8:30 A. M., July 15th, the lot shows a few top embryos, many pathological bottom larvæ and large ciliated infusoria. At 8:15 P. M. infusoria have nearly whole field to themselves.

Expt. 64, at 5:15 P. M. Infused $\frac{1}{20}$ cc. sp. of No. 56 [0 + 0] into 2 cc. sea-water = solution A. Solution B was made by infusing $\frac{1}{10}$ cc. of solution A into 5 cc. sea-water. Solution C was made by adding 1 cc. solution A to 4 cc. of B. Representing sp. of No. 56 by 1, solution A = $\frac{1}{40}$, B = $\frac{1}{2000}$ and C = $\frac{1}{200}$. A film of solution B gives about 100 active sp. to field with power 3 III. Leitz, with tube extended (200 ×).

Next the gonad of No. 57 [0 + 0] was peeled and crushed in 6 cc. sea-water. One cc. of this solution was placed in each of four dishes, with 3 cc. sea-water. At 6:00 P. M. fertilized dishes as follows:

(*a*)	Fertilized with	1 cc.	solution	B.
(*b*)	"	$\frac{1}{10}$ cc.	"	C.
(*c*)	"	$\frac{5}{10}$ cc.	"	C.
(*d*)	"	1 cc.	"	C.

At 8:00 A. M., July 15th, found most embryos in (*d*) and least in (*b*). Only a few top embryos were present, still fewer bottom embryos, many irregular eggs, and many rounded.

Obs. 15. Sp. in above expt. became motionless at 8:00 P. M., July 14th.

Expt. 65, at 6:25 P. M. Eggs of No. 58 [0 + 0] fertilized by sp. of No. 56 by ordinary method. At 8:00 A. M., July 15th, found numerous fine top embryos, a few bottom ones and many rounded eggs. Larvæ of this expt. and Expt. 64 were poured into one dish.

July 15th, Tuesday.

Expt. 66, at 9:45. Eggs of No. 59 [5 + 0] fertilized by sp. of No. 58 [0 + 1]. At 11:45 sp. are quiet; at 2:15 eggs are in stage X.

Expt. 67, at 9:45. Sp. of No. 58 [0 + 1] infused into sea-water. At 11:45 sp. are abundantly active; so also at 1:00; at 2:15 dead.

Expt. 68, at 10:00 A. M. Eggs of No. 60 [5 + 0] fertilized by sp. of Nos. 61 [5 + 0] and 58 [0 + 1]. At 11:45, motion of sp. about ended; at 2:15, eggs in stage IX.

Expt. 69, at 10:15 A. M. Eggs of No. 62 [5 + 0] fertilized with sp. of No. 61 [5 + 0]. At 11:45, sp. occasionally active; at 2:15. eggs irregular, showing much dirt; no development.

Expt. 70, at 10:15 A. M. Sp. of No. 61 [5 + 0] infused into sea-water. At 11:45, abundantly active; also at 1:00; dead at 2:15.

Expt. 71, at 10:45 A. M. Eggs of Nos. 63 and 64 [1 + 0] fertilized by sp. of No. 61. At 11:45, motile sp. rare; at 2:15, eggs irregular, few and with much dirt; no development.

Expt. 72, at 10:45. Infused granules of Nos. 63 and 64 [1 + 0] into sea-water. At 11:45, no motion (except the Brownian) exhibited. Otherwise, size and regularity of granules made the milky fluid resemble that of the male oyster.

Expt. 73, at 8:00 P. M. Stratified most advanced embryos, stage XIV., and used top embryos for the expt. Prepared solutions of two per cent. sea-water and well-water at 66° Fah., into which they were placed.

(*a*) Two parts sea-water to one of well-water (= 1⅓ per cent.) The embryos become slower in movement; rotate.

(*b*) Equal parts of two per cent. sea-water and well-water (= 1 per cent.); rotation as above, and some swimming at 8:15.

(*c*) One part sea-water to two parts well-water (= ⅔ per cent.) Embryos stop motion at once, but slight rotation and ciliary movement resumed later; traces of motion at 8:15.

(*d*) One part sea-water to three parts well-water (= ½ per cent.) causes disruption and decomposition.

These lots were found swarming with infusoria at noon, July 16th. The weaker solutions had the largest infusoria; the strongest, the smallest (monads).

Obs. 16. A few drops of ten per cent. solution of artificial sea-water quiet the embryos at once, but not the trembling of cilia. Some embryos still dance about.

July 16th, Wednesday.

Expt. 74, at 2:30 P. M. Sp. of No. 53 [0 + 2] infused into sea-water; not active at once; active at 3:00.

Expt. 75, at 2:30 P. M. Sp. of No. 61 [5 + 1] infused into sea-water; active at once; active at 3:00.

Expt. 76, at 2:30 P. M. Eggs of No. 60 [5 + 1] fertilized by sp. of No. 61 [5 + 1]; at 3:00 sp. were active.

Expt. 77, at 2:30 P. M. Eggs of No. 65 [2 + 1] fertilized by sp. of No. 61 [5 + 1]; at 3:00 sp. were active. Bottled sp. of Nos. 53 and 61.

Further observations on these expts. were prevented for several days, and thus they show only the state of sp. of these oysters at date, in the given conditions.

July 19th, Saturday.

Expt. 78, at 12:25. Eggs of No. 68 [0 + 0] cleaned and put into a series of solutions of artificial sea-water of strengths as indicated in the first column of following table. At the hours marked in the top line the eggs were fertilized by sp. of No. 67 [0 + 0] by being transferred to spermatized sea-water. The table records the condition at the hours indicated throughout the body of the table. The ratios of 5 per cent. solution to well-water are given in the first column:

	12:30.	12:50–1:05.	1:45.	NOT TRANSFERRED. 2:00 P. M.
5/13 per cent. 1 : 12	3:15, eggs stage X. 4:00, some segt'd.	4:00, some segt'd.	4:00, some irregularly segt'd.	4:00, none segt'd.
½ per cent. 1 : 9	3:15, eggs stage X. 4:00, many segt'd.	4:00, some good, some irregular.	4:00, good.	4:00, few segt'd.
5/7 per cent. 1 : 6	3:15, eggs stage X. 4:00, many segt'd.	4:00, some good, some irregular.	4:00, fair.	4:00, none segt'd.
1 per cent. 1 : 4	3:15, eggs stage X. 4:00, many segt'd.	4:00, many good.	4:00, good.	4:00, some segt'd.
1¼ per cent. 1 : 3		3:15, eggs stage X. 4:00, many good.	4:00, many segt'd.	4:00, few segt'd.
1⅔ per cent. 1 : 2		3:15, eggs stage X. 4:00, many.	4:00, some.	4:00, few segt'd.
2½ per cent. 1 : 1		3:15, eggs stage X. 4:00, some segt'd.	4:00, many segt'd, some irregular.	4:00, none segt'd, some rounded eggs.
3⅓ per cent. 2 : 1	4:00, few segt'd.	3:15, few segment'g. 4:00, poor.	4:00, few segt'd, some rounded.	4:00, none segt'd, some rounded.
3¾ per cent. 3 : 1	3:15, eggs stage X. 4:00, few same stage.	4:00, some irregularly segt'd.	4:00, many irregularly segt'd.	4:00, none segt'd, none rounded.

July 21st, 1:00 P. M. Embryos for all except last column.

July 21st, Monday.

At 1:00 P. M. many amœbæ had developed in the weaker per cent. dishes.

At 2:45 put all embryos into one dish.

At 6:20 embryos succumbing to large infusoria.

Expt. 79, at 3:30 P. M. Eggs of each side of No. 68 [0 + 2] fertilized separately by sp. of right side of No. 67 [0 + 2]. At 5:30, eggs in stage III.

The following table shows the ratios of the various matters in the two lots at different times, and of the different strata of the lot from the left side at a later date. Several microscopic samples were taken, and the figures give the sum of all estimates:

Time.	Lot.	Unchanged eggs.	Shrunken.	Swollen.	Rounded.	Segmented.	Embryos.	Infusoria.	Debris.
July 21, 5:30 P. M. ...	Left.	60	...	...	...	18	....	Many. (6:20 P. M.)	
	Right.	181	...	...	...	8	....	None. (6:20 P. M.)	
July 22, 8:00 A. M. ...	Left.	1	...	6	20	5	4 normal. 1 pathological.	Many.	Some.
	Right.	8	...	20	10	1	None.	None.	Much.
3:30 P. M.	Left.	......	4	6	30	8 irregular	5	....	
Stratified, "Left" at 3:30 P. M.	1st settlings.	......	...	6	68	14 "	8 good. 7 pathol. ...	Many.	
	Top.	......	...	3	5	2 "	27 good.	....	
	Near bottom.	......	...	3	3	2 "	12 good.	....	
July 23, 2:00 P. M. ...	Top.	......	...	...	...	....	Some good.	Many.	
	Bottom.	......	...	...	...	....	Some good.	Many.	Much.

Expt. 79½, July 23d, at 2:45. Embryos of Expt. 79 sorted out and put into solutions of artificial sea-water as follows:*

(*a*) 3⅓ per cent.—2:45, infusoria sluggish; embryos shrunken, but active, on surface; 4:15, some of embryos are still normal.

(*b*) 2 per cent.—4:15, embryos normal.

(*c*) 1⅓ per cent.—2:45, embryos feebly active; 4:15, embryos appear to have recovered.

(*d*) 1 per cent.—2:45, embryos faintly active; swim on surface; 4:15, embryos quite feeble.

(*e*) ⅔ per cent.—2:45, embryos faintly active; infusoria active; 4:15, embryos pathological, but feebly active; disorganization.

(*f*) ½ per cent.—2:45, embryos motionless, swelling and discoloring; infusoria, transparent variety, quiescent; 4:15, a few embryos active, but feeble; infusoria active, but swollen.

July 24th, at 12:45, found many infusoria and much debris in all lots, and a few embryos in all except (*a*) and (*b*).

Expt. 80, at 3:45. Eggs of both sides of No. 68 [0 + 2] mixed and infused into solutions of artificial sea-water of strengths shown below. At hours shown below these were fertilized by sp. of No. 67 [0 + 2] and divided into two sets (one set being left in solutions of the designated strength and one set being transferred to two per cent. (natural) sea-water).

* The well-water used for diluting was of 60° Fah.

Series.	When fertilized.	When examined.	Solutions—per cent.	Unchanged.	Shrunken.	Swollen.	Rounded.	Segmented.	Embryos.	Infusoria.	Dirt.
Transferred	July 21, 4:00 P. M.	July 22, 12:00 M.	(a) 3⅓	...	...	...	1	3 advanced.	3	Many.	...
	" "	" "	(b) 2	...	...	8	20	14 (2 irreg.)	3	Many.	8
	" "	" "	(c) 1⅓	...	...	...	5	10 (2 irreg.)	...	Some.	8
	" "	" "	(d) 1	4	...	9	28	6	3	Many.	9
	" "	" "	(e) ⅔	2	...	4	9	2	1	Many.	6
	" "	" "	(f) ½	...	...	24	36	...	...	Few.	...
Not transferred	July 21, 4:00 P. M.	July 22, 10:00 A. M.	(a) 3⅓	...	3	6 vesicular.	...	...	...	Some.	4
	" "	" "	(b) 2	...	...	2	4	2	...	Many.	8
	" "	" "	(c) 1⅓	1	...	2	7	1	...	Many.	5
	" "	" "	(d) 1	...	...	Some.	14	...	Decomposing.	Very many.	...
	" "	" "	(e) ⅔	...	...	...	9	...	Nearly eaten up.	Numerous.	...
	" "	" "	(f) ½	...	...	8 vesicular.	9	8	...	Many.	Lumps.
Transferred	July 21, 5:00 P. M.	July 22, 1:00 P. M.	(a) 3⅓	8	...	15	19	8 (some irreg.)	2	Many.	6
	" "	" "	(b) 2	4	...	13	30	2	...	Many.	16
	" "	" "	(c) 1⅓	1	...	5	6	3 irreg.	1	Many.	5
	" "	" "	(d) 1	4	...	16	7	2	...	Many.	12
	" "	" "	(e) ⅔	...	...	18	14	3	...	Some.	Many.
	" "	" "	(f) ½	2	8	13	29	3 (Stage VI.)	...	Many.	Many.
Transferred	July 21, 6:00 P. M.	July 22, 11:00 A. M.	(a) 3⅓	5	...	40	50	...	...	Some.	Some.
	" "	" "	(b) 2	...	...	1	15	1	...	None.	2
	" "	" "	(c) 1⅓	...	...	4	3	6	...	Many.	3
	" "	" "	(d) 1	...	...	...	25	2	...	Many.	...
	" "	" "	(e) ⅔	...	...	16	11 granular.	...	...	Very many.	Much.
	" "	" "	(f) ½	...	...	6	13 decomposing	...	...	Many.	Much.
Not transferred	July 21, 6:00 P. M.	July 22, 9:00 A. M.	(a) 3⅓	...	25	30	...	...	...	...	...
	" "	" "	(b) 2	...	30	10	...	...	...	...	...
	" "	" "	(c) 1⅓	3	...	20	50	12	...	Some.	Some.
	" "	" "	(d) 1	Few.	...	50	60	None.	...	Some.	Much.
	" "	" "	(e) ⅔	...	...	40	100	...	...	Some.	Much.
	" "	" "	(f) ½	...	...	Nearly all.	Nearly all.	...	...	...	Very much.

N. B.—The figures in the last column indicate the number of flocculent islands of decomposing eggs, embryos, etc., visible in a microscopic field.

At 4:00 P. M., July 22d, poured all series together.

At 2:00 P. M., July 23d, many infusoria and embryos at surface.

At 12:45, July 24th, the bottom embryos are still active.

Obs. 17, at 4:00 P. M., July 21st. When first series of Expt. 80 was fertilized, the sp. [0 + 2] were observed as follows:

(*a*) 3½ per cent.—At 4:15, no motion.
(*b*) 2 " 4:15, many active; still active at 5:00; at 6:00, dying; feeble at 7:00 P. M.
(*c*) 1½ " 4:15, many active; at 5:00, feebly active.
(*d*) 1 " 4:15, some active; at 5:00, dead.
(*e*) ¾ " 4:15, some active; dead at 5:00.
(*f*) ½ " 4:15, none active.

Expt. 81, at 7:00 P. M., July 21st. Eggs of No. 69 [0 + 2], from each side, fertilized separately by sp. of No. 67. At 8:00 A. M., July 22d, examined and found *left side* much like right, but no embryos and much debris; *right side*, 1 embryo, 3 rounded, 2 unchanged eggs, 200 shrunken, and many monads.

Expt. 82, at 7:00 P. M., July 21st. Eggs of both sides of No. 69 [0 + 2] fertilized by sp. of No. 67 [0 + 2]. At 8:00 A. M., July 22d, much dirt; no embryos.

July 22d, Tuesday.

Expt. 83, at 3:45 P. M. Infused eggs and sp. from Nos. 61 [5 + 7], 67 [0 + 3], 71 [0 + 0] and 73 [0 + 0] (males) and Nos. 63 [1 + 7], 65 [2 + 6], 68 [0 + 3] and 74 [0 + 0] (females) into separate dishes of sea-water. At 1:00 P. M., July 23d, examined glasses and found no infusoria developed in Nos. 65, 68 and 61. The others had few to quite many infusoria of the sort that develop in experiments. The same were found in stomachs of these oysters.

July 23d, Wednesday.

Obs. 18, at 4:15 P. M. Examined the contents of the stomachs of all the oysters of Nos. 63 [1 + 8], 64 [1 + 8], 73 [0 + 1] and 74 [0 + 1], with following result:

Nos. 63 and 64, three specimens (females), infusoria present in stomachs of all.

No. 73, four specimens (males):
(*a*) Few infusoria.
(*b*) Some cytohelminths in intestine and an unknown larva and few infusoria in stomach.
(*c*) Several monads and cytohelminths present.
(*d*) Many infusoria present.

No. 74, four specimens (females):
(*a*) A few infusoria; eggs not uniform.
(*b*) Infusoria nearly absent; eggs as in (*a*).
(*c*) A few infusoria.
(*d*) Cytohelminths and infusoria present. This had been covered by shell after opening.

July 24th, Thursday.

Expt. 84, at 2:00 P. M. Sorted eggs of No. 74 [0 + 2] (*a–d*) mixed (and made successive stratifications of special portions of each sub-experiment), as follows:

Expt. 84*a*. Stratified one-minute "top" of Expt. 84, with results as follows: Two-minutes top shows 17 eggs, mostly swollen, and much dirt; five-minutes bottom ($\frac{1}{10}$ cc. diluted and microscopic sample taken) shows 22 swollen and 37 nearly rounded.

Expt. 84*b*. Sorted this ($\frac{1}{10}$ cc. diluted to 1 cc.) sample by shaking, and sample of "dirt clouds" showed 12 swollen eggs and 100 other eggs that appear to have begun the swelling process.

Expt. 84*c*. Stratified balance of five-minutes "bottom" of Expt. 84*a* and found: One-minute bottom ($\frac{2}{10}$ cc. diluted and sampled) shows 11 swollen and 40 eggs nearly rounded; five-minutes top shows 11 swollen, none others; five-minutes bottom shows 6 swollen, 94 nearly rounded.

Expt. 84*d*. Stratified balance of five-minutes settlings of Expt. 84*c* in 6 cc. of 1$\frac{2}{3}$ per cent. diluted sea-water and found: Top clear after a few minutes, with fine dirt, but no eggs; top of denser stratum below shows 3 swollen eggs and 50 nearly rounded; top stratum, sampled second time, gives 8 eggs, of which 6 are swollen.

Expt. 84*e*. Sorted residue of Expt. 84*d* and repeated for the new resulting residue.

Expt. 84*f*. Sorted top of Expt. 84*e* and repeated for the new resulting top.

Obs. 19. Compared final residue of Expt. 84*e* with final top of Expt. 84*f* and found no difference. This at first surprised me, but reflection showed that as the stratification had been repeated so many times, the lightest and heaviest elements had been eliminated, so that further sorting could effect no further differentiation. Besides, we must consider the continued action of the sea-water on the eggs, decomposing them.

Expt. 85, at 3:00. Eggs of No. 74*d* [0 + 2] fertilized by sp. of No. 73 [0 + 2] and stratified:

Expt. 85*a*. Stratified settlings of Expt. 85 (diluted).

Expt. 85*b*. Stratified five-minutes settlings of 85*a* (diluted). Five-minutes top consists of few eggs and of light dirt.

Expt. 85*c*. Stratified five-minutes top of Expt. 85*a*; repeated, and all one-minute settlings put together as "bottom;" all five-minutes top as "top," and balance as "middle." See Obs. 20.

Expt. 85*d*. Stratified "middle" of Expt. 85*c* and found no clear stratum on top after five minutes.

Expt. 85*e*. Stratified "bottom" Expt. 85*c* and found a clear top stratum, three-quarters of an inch deep, after five minutes.

Obs. 20, July 25th, at 1:00 P. M. Examined lots of Expt. 85*c* as follows:

LOTS.	EGGS.			EMBRYOS.			Infusoria, parasites, etc.	Debris.
	Rounded, opaque, granular, etc.	SEGMENTED. Regular.	SEGMENTED. Irregular.	Top.	Bottom.	Pathological.		
Bottom	64	38	23	26	33	8	Many.	....
Middle	7	1	5	2	20	7	Unknown larvæ.	8 flocculations.
Top	2	4	1	1	1	1	....	Much, flocculent.

Expt. 85*f*. Stratified "middle" and "top" mixed of Expt. 85*c*.

Expt. 85*g*. Sorted two-minutes bottom of Expt. 85*f*, by suction, with this result:

LOTS.	EGGS.			EMBRYOS.			Infusoria, parasites, etc.	Debris.
	Rounded, opaque, granular, etc.	SEGMENTED. Regular.	SEGMENTED. Irregular.	Top.	Bottom.	Pathological.		
Top	......	1	......	1	4	......	....	Much.
Residue	18	5	9	1	11	......	....	7 decomposing eggs.

Expt. 85*h*, at 4:00 P. M., July 25th. Stratified "bottom" of Expt. 85*c* as below:

LOTS.	EGGS.			EMBRYOS.			Infusoria, parasites, etc.	Debris.
	Rounded, opaque, granular, etc.	SEGMENTED. Regular.	SEGMENTED. Irregular.	Top.	Bottom.	Pathological.		
Bottom	44	21	10	1	8	......	....	6 decomposing eggs.
Middle	12	5	8	5	9	2	....	....
Top (diluted much)	4	......	......	2	......	......	....	....

July 25th, Friday.

Expt. 86, at 2:40 P. M. "Top" embryos of Expt. 85 (Expt. 85*c*, Obs. 20, Expt. 85*g* and same as "top," Expt. 85*h*) were placed at bottom of a graduate of sea-water. At 3:45, found all embryos ascended to top.

Obs. 21. Found bottle containing infusoria and relics of former lots of embryos presenting a clear fluid above, with a cloud in its center. Exam-

ined this cloud and found it composed of infusoria engaged in the swarming preliminary to conjugation. This cloud remained intact several days. If disturbed or broken up, it soon was formed again. The nuclei (opaque specimens) in conjugating and other individuals glowed with a rosy, lavender light. In some (transparent specimens) the contractile vesicle showed this rosy tint. This vesicle beats on an average of once a minute; appears slowest in the quietest individuals. This tint or glowing of the nucleus is probably not specially significant, except from a physical standpoint.

July 29th, Tuesday.

Obs. 22. At Perth Amboy, Capt. J. E. Noe opened four Raritans (cullens) and found one ripe female; the other three had spawned.

July 30th, Wednesday.

Obs. 23. Capt. James Bedle, Keyport, opened several oysters (Nos. 82, 83, 84) and showed spawn in them. He also reported that the Newark Bays were in spawn, and that they had been in spawn once before this summer, with an intermission between. He thought that the Virginias just opened were in their second spawning, and further reported that he had seen Southern oysters spawn more than twice in some seasons. The Raritan natives spawn twice, because frequently the seed taken in the fall is of two sizes; the larger size representing the earlier or first spawning; the smaller, the later or second spawning.

N. B.—Visited Keyport August 10th and examined oysters for spawn; also brought some to New Brunswick and examined them there. Hence, the record of this obs. will be found under Fourth Set.

Fourth Set.

NEW BRUNSWICK EXPERIMENTS.

July 31st, Thursday.

Obs. 24. Nos. 77–80 [0 + 1] had fermented and were frothy and filled with maggots.

Expt. 87. Eggs of No. 79 [0 + 1] were fertilized by sp. of No. 81 [0 + 1]. Examined August 1st; no development.

Expt. 88. Eggs of No. 84 [0 + 1] fertilized by sp. of No. 82 [0 + 1]. Examined August 1st; show no development.

August 2d, Saturday.

Obs. 25. Opened Nos. 85 and 86 [4 + 0], but as only one unspawned individual (a male) was found, I projected no fertilization experiments.

Expt. 89. Placed the seven individuals of No. 87 [4 + 0] in two per cent. artificial sea-water, each in a separate jar, with 1,300 cc. water. Soon all had opened and were breathing. They quickly shut the valves of shell when touched or tapped with a knife. Observing to see how soon they would open, I noticed that all opened finally, but in different order from

that followed in tapping them. Also before last had opened, the ones that opened first shut of their own accord, and repeated this several times. The rate of this snapping of the shells was different in all the individuals. Each snap as it occurred was now numbered in its order successively, and credited to the oyster that closed, as follows:

(*a*) ——.
(*b*) 12, 15, 17.
(*c*) 1, 19.
(*d*) 5, 10, 16.
(*e*) 3, 6, 9, 13, 14, 18.
(*f*) 2, 4, 7, 8, 11.
(*g*) ——.

The oysters snapping most frequeutly did so most vigorously, and also opened most rapidly. The rhythm of each oyster appeared constant.

August 8th, Saturday.

Expt. 90. Placed Nos. 88 and 90 [1 + 0] in two per cent. artificial sea-water, as in Expt. 89. The most active at the snapping performance was 90*d;* the least active, 90*a*, 90*c*, 88*a*, 88*c*. A few "snaps" of the first and last mentioned undoubtedly missed being observed. The following numbers show the time when each snap occurred:

No. 88*a*, 4:49½ P. M.; No. 88*b*, 4:48, 4:51¼, 4:55, 5:00, 5:02⅔, 5:07, 5:10; No. 88*c*, 4:54, 4:59; No. 90*a*, 4:51, 4:52¾; No. 90*b*. 5:03, 5:04, 5:05¼, 5:07, 5:08¾, 5:11; No. 90*c*, 4:50¾, 5:10; No. 90*d*, 4:47, 4:48⅔, 4:50, 4:51½, 4:52½, 4:54, 4:55¼, 4:56½, 4:58, 4:59½, 5:01, 5:02¾, 5:04¾, 5:06⅙, 5:07½, 5:09⅙, 5:12. Here observation was suspended a while. Resumed at 5:24¼, 5:25¾, 5:27⅙, 5:28½, 5:30, 5:31½, 5:32⅝—remains shut.

The intervals in No. 88*b* are: 3¼, 3¾, 5, 2⅔, 4⅓, 3—average, 3⅔ minutes; in No. 90*b* are: 1, 1¼, 1¾, 1¾, 2¼—average, 1⅗ minutes; in No. 90*d* intervals are: 1⅔, 1⅓, 1½, 1, 1½, 1¼, 1¼, 1½, 1½, 1½, 1¾, 2, 1$\frac{5}{12}$, 1⅓, 1⅔, 2⅚, —, 1½, 1$\frac{5}{12}$, 1⅓, 1½, 1½, 1⅛. Average is 1$\frac{7}{12}$ minutes. Departures from this of more than nominal importance are rare in this series.

Obs. 26. August 9th two of above specimens were dead; the others were removed from the water and not replaced until August 11th, Tuesday. By Thursday, August 13th, all [6 + 0] were dead; the water full of infusoria. These experiments tally with last year's experience in keeping oysters alive in limited quantities of sea-water. They should be continued with all possible conditions that can be effected, which may be considered to affect the oyster. This set of experiments is to be considered as simply introduced by the above few experiments, and a more extended series is contemplated as a continuation of the set.

August 10th, Monday.

Obs. 27. Examined samples of Newark Bays and other Northern plants. No traces of spawn could be found. In Southern oysters only the youngest show spawn, and then only in traces, in one out of five individuals.

§ 9. *Subaqueous-climate Tables.*

TABLE VI.—Temperature of Water on or near Oyster-Beds at Oceanic (O. T. Allen, Observer).

Date.	Time of high water.	Hour of observation.	State of tide.	Depth—feet.	Temperature—degrees Fahr.	Specific gravity.	Remarks (character, water, etc.)
April 11...	....	....	....	6	46½	1.002	Observed by author.
" 16...	7:00	12:00 M.	Ebb.	7	58½	1.012	Water clear.
" 17...	8:00	8:00 A. M.	"	8½	49	1.013	
" 17...	8:00	5:00 P. M.	Flood.	7	56	1.007	
" 18...	8:45	11:00 "	Ebb.	7	52	1.007	
" 19...	9:30	11:30 "	"	8	49	1.010	
" 20...	10:15	10:00 "	High.	8	50	1.010	
" 21...	11:00	5:30 "	Low.	6	55	1.005	
" 22...	11:30	6:00 "	"	7	56	1.004	
" 23...	12:00	12:00 "	High.	8½	54	1.004	
" 24...	12:45	1:00 "	"	8	55	1.005	
" 25...	1:30	1:30 "	"	8	55	1.007	
" 26...	2:30	2:00 "	"	8½	52	1.011	
" 27...	3:00	9:30 "	Low.	7	52	1.004	
" 28...	4:00	4:00 "	High.	8½	54	1.005	
" 29...	5:30	5:00 "	"	7½	55	1.005	
" 30...	7:00	1:00 "	Low.	7	56	1.005	
May 1...	7:30	10:30 "	Ebb.	7	58	1.005	
" 5...	12:00	12:00 "	High.	7½	62	1.005	
" 6...	1:00	1:00 "	"	7½	62	1.005	
" 7...	2:00	2:00 "	"	7½	61	1.005	
" 12...	5:00	5:00 "	"	10	60	1.007	
" 13...	5:45	5:45 "	"	7½	61	1.006	
" 14...	6:30	6:30 "	"	7½	61	1.006	
" 15...	7:00	1:00 "	Low.	7	62	1.007	
" 16...	8:00	2:00 "	"	7	61	1.007	
" 17...	8:45	2:00 "	"	7	62	1.007	
" 27...	4:30	4:30 "	High.	8	63	1.005	
" 31...	6:30	6:00 "	"	7½	67	1.005	
June 1...	10:30	4:30 "	Low.	7	72	1.010	
" 6...	12:30	3:00 "	Ebb.	8	73	1.006	
" 10...	5:00	6:00 "	High.	8	73	1.002	
" 11...	5:30	1:00 "	Low.	7	77	1.005	
" 11...	6:00	6:00 "	High.	8½	77	1.010	
" 13...	6:30	5:30 "	"	9	68	1.005	
" 16...	9:00	5:30 "	"	9	72	1.005	Water slightly red; thickish.
" 18...	11:00	5:00 "	Low.	6½	74	1.005	
" 22...	1:00	1:00 "	High.	9	70	1.010	Clear.
" 26...	5:30	5:30 "	"	9½	73	1.010	
" 27...	6:00	11:00 "	Low.	7	74	1.008	
" 28...	6:00	11:30 "	"	7	75	1.008	
" 30...	7:00	1:00 "	"	7	75	1.008	
July 2...	8:00	2:00 "	"	8	76	1.010	
" 3...	9:00	3:00 "	"	8	74	1.010	
" 5...	10:00	4:00 "	"	8	74	1.010	
" 7...	12:00	12:00 "	High.	8	76	1.011	Taken by author on oyster-beds.
" 8...	1:00	8:30 "	Low.	Shore.	78	....	Observed by author.
" 8...	....	3:00 "	Ebb.	Shore.	82	....	" " "
" 12...	5:00	12:00 "	Low.	8	76	1.011	
" 19...	12:00	1:00 "	High.	8	75	1.012	
" 22...	3:00	3:00 "	High, flood.	8	74	1.011	
" 24...	4:30	4:00 "	"	8	75	1.011	
" 26...	11:00	11:00 "	High, ebb.	7	75	1.010	
" 28...	1:00	12:00 "	"	7	76	1.010	
" 31...	3:00	3:00 "	"	7	78	1.011	
Aug. 2...	4:00	4:00 "	"	7	80	1.011	
" 4...	6:00	6:00 "	"	7	79	1.012	
" 6...	8:00	8:00 "	"	7	80	1.012	Water slightly muddy.
" 8...	10:00	10:00 "	"	7	80	1.012	
Nov. 15...	3:00	3:00 "	High, flood.	7	48	1.008	
" 22...	9:00	3:00 "	Ebb.	7	42	1.008	

TABLE VI.—Temperature of Water on or near Oyster-Beds at Oceanic—(Continued).

Date.	Time of high water.	Hour of observation.	State of tide.	Depth—feet.	Temperature—degrees Fahr.	Specific gravity.	Remarks (character, water, etc.)
Nov. 29...	4:00	10:00 P. M.	Ebb.	7	40	1.007	
Dec. 7...	6:00	10:00 "	"	7	38	1.007	
" 13...	12:00	1:00 "	High, ebb.	7	38	1.008	
" 20...	6:00	2:00 "	Flood.	7	36	1.008	
" 27...	11:00	3:00 "	Ebb.	7	36	1.008	
1891.							
Jan. 3...	1:30	1:00 "	High, ebb.	7	33	1.008	
" 10...	6:00	8:00 "	Flood.	7	32	1.009	

TABLE VII.—Temperature of Water on or near Oyster-Beds at Keyport (Jos. B. Aumack, Observer).

April 16...	....	....	....	....	58	....	Taken by author.
" 21...	....	10:00 A. M.	....	7	50	....	Water clear.
" 24...	....	12:00 P. M.	High.	9	56	1.010	
May 2...	....	2:00 "	Half flood.	4	55	....	
" 12...	....	9:30 A. M.	First flood.	5	57	....	
" 12...	....	10:30 "	....	10	55	....	
" 15...	12:00*	2:00 P. M.	....	5	63	....	
" 27...	....	9:00 A. M.	....	6	63	....	
" 29...	....	6:30 "	Ebb.	6	61	....	
" 31...	....	8:00 "	First of ebb.	5½	62	....	
June 2...	....	9:00 "	Ebb.	7	66	....	
" 4...	....	9:00 "	High.	12	65	1.010	
" 5...	....	10:00 "	....	9	68	1.010	
" 9...	....	5:00 "	Ebb.	5	66	1.010	
" 10...	....	8:00 "	Flood.	4	68	1.015	
" 11...	....	6:00 "	Partly ebbed.	6	68	1.010	
" 11...	....	1:00 P. M.	Half flood.	5	74	....	
" 12...	....	2:00 "	High.	6	72	1.010	
" 13...	....	2:00 "	Half flood.	4½	70	1.010	
" 14...	....	7:00 A. M.	High.	8	68	1.010	
" 16...	....	8:00 "	"	10	70	1.010	
" 17...	....	11:00 "	Ebb.	7	69	1.010	
" 18...	....	6:00 "	Flood.	4	68	1.010	
" 19...	....	9:00 "	Ebb.	6	72	1.010	
" 20...	....	7:00 "	Flood.	7	72	1.011	
" 21...	....	8:00 "	....	6	69	1.020!?	
" 23...	....	6:30 "	Low.	7	69	1.012	
" 24...	....	10:30 "	High.	8	69	1.010	
" 30...	....	11:00 "	Low.	6	74	1.010	Water muddy.
July 7...	....	8:00 "	Flood.	5	74	1.015	
" 8...	....	7:00 "	Low.	5	74	1.015	
" 9...	....	10:00 "	Flood.	6	77	1.015	
" 10...	....	1:00 P. M.	"	7	74	1.012	Water muddy.
" 10...	....	3:00 "	High.	Wharf.	73	....	By author.
" 11...	....	10:00 A. M.	Low.	....	72	....	" "
" 11...	....	1:00 P. M.	....	....	72	....	" "
" 12...	....	7:00 A. M.	Part ebbed.	7	73	1.020!?	
" 12...	....	2:15 P. M.	....	....	74	....	" "
" 14...	....	7:00 A. M.	Ebb.	9	70	1.020?	
" 14...	....	2:30 "	Low.	....	73	....	" "
" 15...	....	10:00 "	Ebb.	5	73	1.012	
" 15...	....	10:45 "	Low.	....	74	....	" "
" 16...	....	6:00 "	Flood.	6	73	1.010	
" 16...	....	3:00 P. M.	Low.	....	80	....	" "
" 19...	....	2:00 "	....	....	74	....	" "
" 21...	....	7:00 A. M.	Flood.	6	67	1.010	
" 21...	....	2:30 P. M.	Low.	....	71	....	" "
" 21...	....	5:30 "	....	....	71	....	" "
" 22...	....	10:00 A. M.	....	....	70	....	" "
" 24...	....	7:00 "	Low.	3	70	1,020?	
" 24...	....	2:00 P. M.	High.	....	72	....	" "

*See Nautical Almanac.

TABLE VII.—Temperature of Water on or near Oyster-Beds at Keyport—Continued.

Date.	Time of high water.	Hour of observation.	State of tide.	Depth—feet.	Temperature—degrees Fahr.	Specific gravity.	Remarks (character, water, etc.)
July 25...	....	1:00 P. M.	High.	4	72	....	Water muddy.
" 25...	....	1:00 "	"	....	74	....	By author.
" 28...	....	7:00 A. M.	Ebb.	6	74	1.015	
" 29...	....	8:00 "	"	5	74	1.011	
" 30...	....	7:00 "	"	6	74	1.010	
" 30...	....	1:00 P. M.	Low.	....	80	....	" "
Aug. 4...	....	8:00 A. M.	Flood.	7	77	1.020?	
" 8...	....	7:00 "	Ebb.	5	75	1.015	
" 10...	....	12:00 M.	....	....	72	....	" "
" 15...	....	8:00 A. M.	Flood.	6	73	1.010	
" 18...	....	1:00 P. M.	Ebb.	6	75	1.010	
" 25...	....	7:00 A. M.	"	5	66	1.010	Muddy.
Nov. 25...	....	8:00 "	"	7	42	1.000	
Dec. 11...	....	9:00 "	"	6	38	1.010	

TABLE VIII.—Temperature of Water on or near Oyster-Beds at Perth Amboy (Jas. E. Noe, Observer).

May 1...	6:00	2:00 P. M.	....	2	61	1.006	By author.
" 2...	8:00	7:00 "	....	5	44	1.010	
" 5...	9:00	7:00 "	....	6	60	1.006	
" 6...	10:00	7:00 "	....	6	58	1.010	
" 7...	12:00	7:00 "	....	5	59	1.010	
" 8...	1:00	7:00 "	....	1	58	1.010	
" 9...	2:00	7:00 "	....	2	58	1.010	
" 11...	3:00	6:00 "	....	8	62	1.010	
" 13...	4;00	6:00 "	....	4	65	1.010	
" 15...	4:00	6:00 "	....	5	62	1.010	
" 16...	5:00	7:00 "	....	4	64	1.010	
" 18...	6:00	7:00 "	....	3	63	1.010	
" 22...	11:00	7:00 "	....	4	65	1.010	
June 3...	6:00	8:00 "	....	4	65	1.010	
" 5...	8:00	7:00 "	....	4	67	1.010	
" 6...	9:00	7:00 "	....	8	66	1.010	
" 7...	10:00	7:00 "	....	2	67	1 010	
" 9...	1:00	7:00 "	....	4	68	1.010	
" 11...	3:00	6:00 "	....	5	68	1.010	
" 13...	5:00	6:00 "	....	4	68	1.010	
" 16...	8:00	7:00 "	....	6	69	1.010	
" 17...	8:00	6:00 "	....	4	70	1.010	
" 19...	10:00	7:00 "	....	4	70	1.015	
" 21...	11:00	7:00 "	....	5	72	1.015	
" 23...	12:00	7:00 "	....	4	72	1.015	
" 25...	1:00	7:00 "	....	5	73	1.015	
" 28...	4:00	7:00 "	....	2	73	1.015	
" 30...	6:00	7:00 "	....	6	74	1.015	
July 1...	7:00	7:00 "	....	7	76	1.015	
" 2...	8:00	7:00 "	....	6	73	1.010	
" 7...	12:00	1:00 "	....	6	78	1.015	
" 8...	1:00	12:00 "	....	6	78	1.015	
" 9...	2:00	2:00 "	....	6	74	1.015	
" 10...	3:00	3:00 "	....	6	74	1.015	
" 11...	4:00	4:00 "	....	6	74	1.010	
" 14...	5;00	5:00 "	....	6	75	1.010	
" 15...	6:00	6:00 "	....	6	76	1.010	
" 17...	8:00	8:00 "	....	5	77	1.015	

§ 10. *A Discussion of the Bearings of the Experiments upon the Solution of Various of our Ostracultural Problems.*

We propose in this section to take up in order the questions of the list given in the introduction (§ 4), omitting those questions upon which the experiments throw no light.

Series A.

SUBMARINE CLIMATE.

Question 2. Tables VI., VII. and VIII. are contributions to the climatology (if we may use the term) of the planted or cultivated oyster-beds of three separate localities that constitute one region of New Jersey. We may, for the present, divide New Jersey's shore into the following oyster regions, including natural and artificial beds under one view: (1) The Hudson River region; (2) The Newark Bay region; (3) Raritan Bay region, including the sub-region of the North and South Shrewsbury rivers (these might properly be put into a region by themselves). Then comes (4) the Barnegat Bay region; next (5) the Egg Harbor region; then (6) Cape May region, and lastly (7) Delaware Bay region. These seven or eight regions are all that legally belong to New Jersey, but from a geographical standpoint, Staten Island is a part of New Jersey, and forms a region that should be studied in connection with the Raritan Bay region. If we desire to understand the effect of environment upon the oyster, it is plain that we must not limit our studies to this State, but should include a comparative study of the coast, at least from Rhode Island to Maryland or Virginia, and better still, from Massachusetts to the Carolinas. It is the hope of the experimenter to have observers in all these regions, that a record may, after a series of years, be made complete enough to enable us to state exactly what peculiarities each region offers in the way of average temperature and density of the sea, and the range and distribution of the variations (extremes or departures from this average). Our tables show that it is difficult to make an oysterman understand the importance of a *continuous* record for a long time. If the record be not made daily, it should, at least, cover high and low water once a week throughout the year. When we consider the trouble required to make observations of this

sort, compared with those of ordinary meteorology, it is no wonder that it is difficult to secure observers, and, when secured, difficult to secure complete records. We thus see how much credit is really due the observers for what they have done. In the absence of compensation it requires an intelligent faith on the part of the oystermen that these records are of ultimate service to the industry in which they are engaged, and upon which their children will depend for support, while returns of a material nature may not accrue to their individual benefit, owing to the brevity of human life as compared with epochs of scientific progress. I have certainly found no lack either of generosity, intelligence or faith among the oystermen I have met; it only requires that these three virtues be united, and directed in the line of work here indicated, to secure faithful and even enthusiastic service. Another matter in these tables must not be taken too literally, viz., the specific gravity. The instrument did not allow of readings nearer to each other than five one-thousandths; and the personal equation has evidently added to this to cause leaps from 1,000 to 1,020 in a record otherwise nearly uniform. More important is the matter of temperature, and here the tables are of real service for the period they cover. They show a steady increase of temperature of the water, from the middle of April to August, the latter limit not well defined, owing to gaps in the tables. *About the middle of June for Perth Amboy and Keyport, and two weeks earlier at Oceanic, the thermometer recorded seventies. About this time the oysters began spawning (earlier by about two weeks at Oceanic).* The other limit of the spawning period, viz., the end, is not so definitely related to temperature. The water of Oceanic attained to the eighties some time after spawning ceased. It seems probable that the spawning period is a time of somewhat determinate length with its commencement dated according to the temperature. An open winter and early warm weather caused oystermen to expect that oysters would spawn earlier. The observer was kept supplied with sample oysters from Oceanic, and was able to keep account of the gradual "fattening" of the oyster preparatory to spawning; and at least a month in advance fixed the date for the Shrewsbury oysters to spawn, with practical accuracy, and also stated that this would be two weeks earlier than usual. Our experiments were begun as soon after the season commenced as was practicable, and lasted throughout the season. *The great object of the records is to enable us not only to*

prophesy concerning the spawning, but also as to the likelihood of a resulting "set." For many years a "set" has failed to appear in Raritan bay, but last season a set was reported to have occurred, the season being very favorable. *By comparison of records and "sets" for a series of years, we shall be able to state positively just what conditions favor a "set," not only for purposes of prognostication, but rather for the more important purpose of enabling us to create the proper conditions in culture-claires in artificial oyster propagation.*

Question 3. It is natural to suppose that a Northern oyster, transplanted to Southern waters, will mature earlier than in its native waters, where it has been accustomed to waiting for the maximum degree of warmth, which degree is reached in the new situation earlier than the maximum proper to the southern location. The reverse results, based upon similar reasoning, apply to a Southern oyster transplanted northward. The experiments bear out this view. Early in the season I was working at the warmest locality, and relied on Northern plants, while later, in cooler waters (compare the tables of temperature for Keyport and for Oceanic), I relied upon Southern oysters to furnish me spawn. But this general indication should be accurately worked out by a series of experiments.

Series B.

REPETITIVE SPAWNING.

Question 3. Materials for the answer of this question, at least partially, are in my hands, but have not been worked up as yet.

Question 5. According to many oystermen, there are several repetitions of the spawning act during a season. Two arguments are given in support of this view. First, the different sizes of the "sets" or seed; second, the fact that oysters opened daily during the season seem to show that they fatten up and become "spawny" after having once "spawned out." The following objections would have to be answered before these facts will weigh for such a theory: Do we know that oysters of different ages spawn together? In fact, we know that the spawning season lasts over a month, and that only some oysters are through spawning early in the season. Further, we have evidence that Northern oysters spawn early and Southern ones late. This is sufficient to account for the different sizes of "sets," and it is

gratuitous to affirm that the same oyster is responsible for the two sets of spawn. As regards the second argument, the oysters that spawn early are early restored, and to the eye it is very easy not to discriminate between the oysters maturing late and those simultaneously in process of restoration. As far as our observations go (see Obs. 29, especially), *there is no good evidence in favor of the theory of repetitive spawning*. But this question, I hold, is still open.

Question 6. This is a question propounded by the experimenter on purely speculative grounds. The European oyster is hermaphrodite, and it frequently happens that unisexual animals have traces of hermaphroditism in their gametogenesis. May not our oysters change sex, either by alternation or by change in age, or at least show hermaphroditism? This question makes the preceding one more important, because if one is true the other theory is more likely to be true, although the questions are still independent. An oyster might readily mature male cells (or *vice versa*) early in the season, and later mature hitherto latent eggs, and finally spawn a third time as a male. But histology has hitherto given no basis for such a theory. In this connection, *Expt. 72* is of interest, and Nos. 55, 57, 58, 63, 64, 80, 83, 84, etc., show all gradations between oysters with a few or many eggs imbedded in many or few granules, to oysters that had nothing but granules. These granules were not distinguishable from spermatozoa with latent period. But Expt. 72 showed that they never became active. Still, it will require histological examination of a series of sections to explain the significance and relation of these granules to other gametogenetic processes.

THE EFFECTS OF POST-MARINAL AGE.

Questions 10, 11 and 12. These three questions can best be considered together, because it is the effect of this post-marinal age on the sexual cells that interests us most, and by which, to a very great extent, the lifetime of the oyster is to be gauged. But several considerations confront us: (1) The reproductive cells of the two sexes are not equally affected; (2) If we take the cessation of response of closure of shell, when the oyster is struck or jarred, as the death-point of the oyster, the male cells survive this event for some time, as shown by Expt. 27 and Obs. 9; (3) It makes very great difference whether the oyster is opened or not as to the length of post-marine

life. In Professor Lockwood's monograph on the Oyster Interests of New Jersey is a story illustrating, first, how the oyster can be educated, and, secondly, how such training tends to lengthen its life, because the shell is kept shut and the juices are retained. *If a low temperature be maintained, an oyster can be kept alive for several months. This fact tends to strengthen any belief we may have that the oyster hibernates in winter*, for only by a process of torpidity or hibernation is such a thing possible.

In the atmosphere of our laboratory, subjected to temperatures ranging from 70° to nearly 100° Fah., the oysters lie with closed valves for several days, and finally they become too feeble to keep the valves shut unless they receive a special stimulus, such as a tap. After oysters "gape" the deterioration is rapid. It is probable that, with a high temperature, the development of bacteria in the "liquor" of an oyster, even if the shell is closed, is the direct cause of the weakened condition, *because a "gaping" oyster is already unfit for food, although still alive.* Nos. 27, 59, 60, 65, 77, 78 "gaped" before opened. Of 59 it is recorded (Table III.) that when four days old it shut its shell when stimulated, but failed to do so the next day. Comparing *Obs. 8 and 9, we learn that the sp. are still active in such oysters.* Adding to the foregoing list, oysters 24 and 26, and Nos. 88 and 90 that were placed in dishes of salt water, we have three series in which to compare the life-period, viz., "not freshened," "freshened," and "submerged specimens." Representing the "not freshened," we have No. 27 [4 + 0], Nos. 59 and 60 [5 + 0] For the "freshened," we have Nos. 77 and 78 [1 + 0], and No. 65 [2 + 0], while not recorded as freshened, was not recorded as "not freshened," and relying simply on memory we classify it here. In the third class we have Nos. 24 and 25 [4 + 0], Expt. 27; No. 26 [3 + 0], Expt. 27; Nos. 88 and 90 [5 + 0], Obs. 26. From which we conclude—first, that *freshening oysters tends to doubly hasten processes of decay,* and secondly, *that whether in or out of water* (of limited area), *the length of life of oysters* after removal from their bed, *is nearly a week at high summer temperatures.* What the results would show at low temperatures, remains for future experimentation.

THE VIABILITY OF THE SPERMATOZOA.

Turning now to study the effect of post-marine age on the spermatozoa, we refer to Table IX. In this table the oysters are arranged in order of post-marine age, adding the "for-open" and "aft-open" days, giving precedence to the "for-open," although if the conditions of moisture could be kept the same it is doubtful (from an inspection of the rather incomplete data) if one set has advantage over the other. In our present study, it is necessary to compare those vertical columns which are most complete, viz., 1 per cent., 1⅞ per cent., 2 per cent., and 2½ per cent. The figures recorded state the minutes the spermatozoa were active, dying (slow), dead, or the actually observed length of life of the spermatozoa in the various solutions. One of the peculiar discoveries brought out by an inspection of the table is this, that *if the spermatozoa be present with eggs (as in fertilization experiments), their time of activity is shortened one-half.* On the strength of this law it becomes necessary to multiply by two all the numbers in the horizontal lines that are marked in the last column "with eggs." This multiplier is here used only by trial for want of a more accurate number which future experiments must establish. The age of the eggs seems to have some influence (especially in connection with aged spermatozoa) in varying this factor, and especially so if the "aft-open" portion of the post-marine age is large, the "for-open" portion having less effect. For this reason the numbers must not be interpreted or used too literally, but general indications should be discovered. *The longest period of life of the spermatozoa was observed with* [0 + 0] *over five hours.* For two-days-old oysters [1 + 1, 0 + 2], two and three hours are recorded, and similar periods are recorded for [5 + 0.] But for a larger number of days than five, especially if the "aft-opened" portion reaches one or two days, *the period is rapidly shortened to the vicinity of half an hour.* The strength of the solution has important bearings, because *the optimal strength for fresh spermatozoa lies between 1⅞ per cent. and 2 per cent., while for oysters a week old this has shifted to 3⅛ per cent.*

One important series of experiments remains to be made in this connection, to show what effect age of spermatozoa, and especially length of sojourn in various solutions, has on the fertilizing power of spermatozoa. Turning our attention to Table X., we learn that

good, fair and passable fertilizations were effected with spermatozoa 0 + 0, 0 + 1, 1 + 0, 2 + 0, 0 + 2 and 2 + 2 days old. Poor and partial results followed the use of sp. [0 + 0, 0 + 1, 1 + 0, 0 + 2], and the results were *nil* with sp. [0 + 0, 1 + 0, 0 + 1, 0 + 2, 0 + 3, 5 + 0, 5 + 1]. Comparing these with the unfavorable solutions, temperatures and eggs, we eliminate from the second list [0 + 0, 1 + 0], and from the third list [0 + 0, 1 + 0, 0 + 1, 0 + 2], so that the practical result is that, with favorable circumstances, while sp. as old as 2 + 2 may succeed in effecting development, the chances are that *after two days of age*, either "aft- or for-open," *the spermatozoa have deteriorated too far for practically successful results.* This age marks the point of rapid decline in the length of time the sp. are active in solutions, there being a fall of one-half, which is not appreciably lowered further for several days. *We should provisionally conclude that spermatozoa that are capable of fertilizing eggs with resulting development remain active in sea-water for at least two hours, and in the presence of eggs for half that period.* Or, in other words, the vitality (viability) of spermatozoa may be weakened by 50 per cent. without destroying their fertilizing power. But future experiments may show that the viability of the embryos has suffered.

There are many causes of deterioration of the sexual cells at work in the natural environments of oysters, and the result is a weakened "set," which either fails to come to maturity as "seed," or else perishes later on the planted beds. It is one of the most important matters in breeding to start with vigorous sexual elements, hence these experiments, crude as they appear in their beginnings, are the entering wedge to lodes of inestimable value.

VIABILITY OF EGGS.

The effect of age on the eggs constitutes the second portion of this inquiry, and involves an inspection of Tables X. to XIII. Table X. shows at a glance that *no successful fertilization experiments were performed with oysters over two days old,* unless No. 48, Expt. 63, can be considered an exception. In fact, the table shows conclusively that *the development is partial* (if there is development at all) *for all oysters older than* [0 + 0]. No. 55, an oyster showing eggs imbedded in granules the day it was received, had probably been weakened by the freshening process to an unusual extent, and for this reason gives

a record that resembles an older oyster. Table XI. shows that *age tends greatly to reduce the rate of development*, as, for instance, compare No. 48 [2 + 2], Expt. 63, No. 59 [5 + 0], Expt. 66, and No. 60 [5 + 0], Expt. 68, with the numbers next to them in the table, and we shall see that the rate is less than half as rapid, but allowance must be made for the possibility that the eggs had ceased developing at the stages noted, for some time before the observation was made. The law would not be invalidated, however, though the figures be modified. Table XII. shows how long eggs can retain their power of development when left in various solutions, unfertilized for different periods. In general, the table shows that *fresh eggs can stand soaking in optimal solutions for at least one and one-quarter hours*, and that eggs one day old give "good" results by exception, while 0 + 2 rises only to "fair" with one-half hour's soaking, and have sunk to "passable" with one and one-quarter hours' soaking.

Table XIII. is somewhat complicated in the large number of components that enter into the resultant. In addition to all the factors shown in the preceding tables, the addition of length of time in which solutions of various strengths act on eggs, whether fertilized or unfertilized, is shown. It will be seen from the table that fresh eggs resist ultimate decomposition in optimal solutions for a long time. The differences between fertilized and unfertilized eggs are not exhibited, owing to paucity of experiments, except that we may conclude that *fertilized eggs become round sooner than the same eggs unfertilized*, from a comparison of Expts. 37, 24 and 26. If No. 46, in Expts. 56, 58 and 62, be studied comparatively, a very clear exhibition of the effects of age will be noted. While length of time of action of the solution is important in old eggs, its action is not apparent in fresh ones. In fact, it will be found that *only a short time is needed to decompose old eggs*. We may sum up all the evidence on this head as follows: The effects of age in deteriorating eggs is very rapid—more so than with spermatozoa—and this effect is *shown* (1) *By decreasing the number of eggs that develop;* (2) *By slowing the rate of development;* (3) *By cutting short the development in early stages;* (4) *By causing pathological development;* (5) *By shortening the period the egg can remain unfertilized;* (6) *In increasing the rapidity of decomposition.* All these factors are at work at once, and while the strongest eggs are the last to succumb, they show the effects, first, in the weakened and pathological embryos produced from

them; next, in partial development; then in ability to simply become round, and lastly, in failure to react at all, except to pass through the stages of decomposition, the degree of weakening and character of the result being thus respectively indicated.

EFFECT OF SOLUTIONS OF DIFFERENT STRENGTHS.

A study of the effects of solutions throws additional light on the subject, for *all these processes are hastened by the presence of unfavorable percentages of sea-water.* An egg deteriorated by age may be able to make a good record in a favorable environment, when unable to do so in an unfavorable one. We thus add a seventh component of forces to be analyzed in this intricate synthesis. By comparing the lines or columns horizontally in Table XIII., this principle is easily recognized. One of the peculiarities of oysters as first received is this: If experimented with at once, they can be classified into groups corresponding with those produced by increment of post-marine age. This shows that *in nature or in their handling they have variously suffered from unfavorable conditions of environment.* It is plain that if the sexual cells have suffered the oyster as a whole has suffered, and is less fit for food (or at least not so easily kept in the market). So that besides the value of this sort of experimentation in discovering the forces that favor the production of vigorous sexual elements, there are more immediate consequences of economic importance.

Question 13. Attention is called to the effects on spermatozoa of the presence of the most important ingredients of sea-water, aside from sodium chloride, in Expts. 14 and 15. But the series of experiments under this head is too short for scientific conclusions. Expt. 17 shows how fatal the products of "fermentation of sea-water" are to spermatozoa. The effects of the refuse and sewage of our great sea-board cities upon oysters require renewed investigation under this head.

SERIES D.

EFFECT OF TEMPERATURE AND SALTNESS.

Question 3. This question has already been partly discussed above, in our study of the effects of age on the sexual cells, as shown by

Tables IX. to XIII. Here we are more immediately concerned with a study of Tables IX. and XII. Table IX. shows—(1) With reference to strength of solution, that *the period of viability is greatest at about* 2 *per cent., but for old oysters* [6 + 0, 6 + 1], etc., *the optimal point is higher up the scale;* (2) This period has a greater range, as measured in per cents, *below* than *above* the optimum, as seen best in Expt. 80, where ½ per cent. and 3⅛ per cent. are equals in power to destroy the life of the spermatozoa; (3) That *above* 80° *the period is shortened by a rise in temperature, but that spermatozoa can live for a time even at* 110° Fah.; (4) That the presence of eggs in the solution rapidly shortens the period; (5) That post-marine age shortens the period. In connection with this point, we have to note that in some fresh oysters the sp. have a latent period, and that oysters kept a week (Obs. 5) may still fail to reveal a latent period. But Obs. 1, 2, 3 and 4 show that in the same oyster a *latent period sometimes develops through the effects of age*, and that there is therefore a correlation between latent period and vitality. *The male oyster resembles the female in presenting different grades of vitality when first harvested, but the sp. are less sensitive than the eggs to environing stimuli.* While this table (IX.) is in some respects the most complete and satisfactory of all our tables, it will require a good deal of work to fill up its lacunæ in a thoroughly scientific manner, so as to permit the plotting of curves representing the variations and relations of the above-mentioned five co-ordinates. *The older eggs appear to have less power to weaken this viability than fresh eggs in fertilization experiments.* Leaving out of account the weakening due to age, it appears reasonable, and harmonizes with my recollection of facts, that high temperatures or the presence of eggs cause an increase of activity, and that this, by exhausting the sp., is directly responsible for the shortening of the period.

As regards Table XII., we had a better test of viability for the eggs (viz., their power to develop) than we applied to the spermatozoa. There can be no doubt that *eggs may remain unfertilized for an hour or longer, and still be able to produce embryos.* This is of immense advantage as far as the chances of getting a "set" are concerned. The deterioration of eggs caused by sojourn in solutions manifests itself most strongly with solutions that are weaker or stronger than the optimal ones. But this effect is not a marked one, in consequence of the *deteriorating effect of unfavorable solutions, even upon fresh eggs, fertilized at once.*

THE DISPERSAL OF SPAWN.

Question 4. This question involves a knowledge of (1) the floating power of the spawn before and during development, (2) of the swimming power of the spawn and embryos, (3) of the direction and rate of currents, and (4) of the length of time the spawn is in suspension or is swimming in the water. Incidentally the temperature and time of spawning with reference to the tides are of importance in guiding to a verdict.

The male cells are the active or locomotor ones, the female are non-motile; but this power of locomotion is not used for the purpose of traveling any but microscopic distances. The progression of a sp. is not in a direct line, the motion is rather a dance than a progression, and does not become determinate except within the radius of influences of the egg (whatever that radius of attraction may be). At any rate, we know the motion of the sp. is "direct" in the micropyle of the egg. Expts. 39 and 41 show that *sp. do not diffuse themselves by travel throughout quiet water.* However, it may be urged that the character of the spermatized water was so different from the surrounding water that the sp. were driven back from entering a foreign stratum. This objection applies equally to the fluid ejected naturally by the oyster; we ought also to know to what distance above the bed the spawn is projected during spawning. The stirring up of the water by waves and currents must be the main agency for diffusing spermatozoa. It may be that the spawning is not done except when the water is quiet, in which case we shall have only the lower stratum of water impregnated. *The eggs* are shown by Expts. 47½, 85*e*, and the stratification experiments in general, to be *heavier than the sea-water, and that in about seven minutes they sink at least an inch.* If the lower stratum of water covering an oyster-bed be full of spawn for a distance of half a fathom up, all the eggs will have settled into the mud before the segmentation is completed; and, for the majority of eggs, probably before it is begun.

The spawn, after attaining the swimming stage, travels with direct motion, at a speed which is quite measurable (though unknown), but still secondary to the rate of flow of tidal currents. *In fact, the ciliary movement is principally made use of to bring the embryo to the surface.* If the water be deep, and the length of time the embryo remains at the surface or near it extend over one or more tides, it is

plain that *the spawn will be transported back and forth, and finally, when ready to settle again, it may be at a distance from its birthplace.* On the natural beds the tide is usually confined between banks, surging back and forth, so that the set is practically limited to the bed otherwise the bed would travel out to sea. (In this discussion we, purposely neglect the influence of presence of collectors, saltness of water and effect of currents for keeping collectors clean, in determining the limits of oyster-beds.) It is plainly needful to make a careful study of currents upon oyster-beds. Expt. 86, compared with Expts. 35 and 36, appears to contradict the latter, but on referring to the calendar (Table V.) and to Table XI., we see that the difference in temperature was great enough to put one set of embryos at the close of stage XIV., while the other set was only at the beginning of this stage. *Stage XIII. is closed by the complete attainment of the surface habit, while stage XIV. is closed by its abandonment as a habit. This period, with favorable temperatures* (between 70° and 80°), *occurs between the twelfth and thirty-sixth hours (roughly speaking), and after that the embryo swims at all levels,* probably in search of a fixation place. Expts. 48, 64, 65 and 79 conform with this interpretation. Profs. Ryder and McDonald found (1882) that at temperatures approaching 80° fixation took place in twenty-four hours.

OPTIMAL SALTNESS.

Question 5. We have for the most part determined the laws governing this point, as seen in Tables IX. to XIII. In Table IX. *the optimal solutions are seen to correspond with the densities of the water at Oceanic and at Keyport.* In all likelihood the oysters become adapted to a certain range or average of saltness, and this determines the *optimum.* The reason why the tolerated solutions range further on the weaker than on the stronger side of the optimal percentages is due to the fact that the natural beds of oysters have from times very ancient been situated in the river estuaries, where the saltness of the water varies much and is considerably reduced. *The waters of Raritan bay may be considered as salt as is practicable for oyster-breeding.* A failure to secure a set cannot be referred to the freshness of the water. Probably temperature is more important. Table X. supports these conclusions very well, for the "good" column contains no solutions above 2 per cent., and exceptionally for weaker per cent. than $1\frac{3}{8}$, but

in this case (Expt. 78) the length of time these solutions acted was very short. Tables XII. and XIII. tell the same story.

ACCELERATION OF DEVELOPMENT.

Question 6 is answered by Table XI. The experiments have been arranged in order from the lower to the higher temperature; the general average for the day during the progress of development, or the maximum for the night, was chosen to represent the number in the record. Certain remarkable conclusions are apparant on studying this table. First, *a rise of* 10°, *from* 70° *Fah. to* 80°, *effects an acceleration of double the rapidity.* In our last year's report we concluded from a study of certain data published by Prof. Rice, that a temperature of at least 80° was most favorable to the development of oysters; a temperature, judging from this experimenter's efforts, which was sought to be avoided, with the result that the temperature was much too low for success. At least 70° Fah. is needed for these experiments; and our studies now show that temperatures running up to 100° are not unfavorable, at least for a short time. In this connection we note that the temperature of the natural waters at Oceanic and Keyport during last season, fulfilled the conditions necessary for securing a set, so far as the temperature factor is concerned. But to be cautious, *we will provisionally decide that the optimal temperature lies between* 80° *and* 90°. Secondly, we find that in the column headed "death," the embryos disappeared at a definite stage of development, the same for all cases, or just previous to the fixation period. We might conclude that fixation had occurred. Still we are loth to believe the embryos survived, as the evidences of dissolution, aside from the myriads of infusoria present, were ample to prove that the embryos died. The remarkable thing is that the point of death offers one of the best evidences of acceleration due to temperature found in the table. It must be that death followed the attainment of a particular stage of development; and we are strongly inclined to believe that this stage marks the point at which the embryo begins to receive food. *Our embryos, therefore, died of starvation,* as well as from the effects of the noxious food available in the breeding-glasses, and of the attacks of enemies. Some method of feeding the embryos at this stage, as well as of keeping their surroundings properly clean and warm, is necessary. This has hitherto

been effected by transferring the embryos to a claire. Two other factors modify the effect of temperature; *e. g.* age and unfavorable environments cause retardation. The effects of age are shown in Table XI., and those of weak and strong solutions in Table XIII., and the "partial" column of Tables X. and XI.

Question 7. This can be answered only after a series of annual comparisons between tables like VI. and VIII., and the absence or presence of a set at the given localities.

Questions 8 and 9. A partial answer to these questions was sought in the stratification experiments, but the results obtained are insufficiently clear for a proper study of this problem. Certain it is that Table XIII. shows that only a fraction of eggs develops; but how to distinguish an egg that will develop from one that will not is still a dark problem, the more so since experimenting upon the subject. The indications are, that all the eggs in an oyster are not mature at once, but there may be no well-marked stages of ripening.

SERIES E.

PARASITES.

Question 1. Last year we reported having found one oyster's gonad filled with gregarines. No similar case has occurred in our later experience, but some light can now be thrown upon that mysterious "nemathelminth" or "crystalline rod" discussed last season. Obs. 10 seems to indicate that *during the time of maturation of the gametes a parasite invades the oyster, which becomes encysted in the form of the "nemathelminth,"* while numerous spores develop into cytohelminths in its interior. Finally the body of the nurse or cyst is decomposed, probably furnishing pabulum for the cytohelminths. The position of this gelatinous rod appears to be in the intestine shortly after it leaves the stomach, and before it makes its first turn forward again. (See note at close of this article.) The cytohelminths are about one one-thousandth of an inch in length, shaped like a nematode worm, but furnished with an undulating membrane along one side, like the spermatozoids of Triton. They are unicellular, and must be classed as infusoria. The name we have given this parasite is formed from two Greek words, meaning "cell" and "worm" respectively, because its form is worm-like, and its structure is that of a cell. Professor

Ryder, in Ferguson's Report, describes a parasite very similar, possibly identical. They are present, in favorable cases, in immense numbers, crowding the intestine and stomach and readily become mixed with the gametes by our method of taking spawn. *They were met with only in the earlier experiments. Besides the above parasites and bacteria, the oysters contain in their stomachs four or five other common parasites* (but not in great numbers), which are infusoria, and which get into the breeding-glasses and rapidly multiply, to the detriment of the oyster embryos. A general survey of nearly all the fertilization experiments (see 78, 80, etc.) shows that these enemies breed most rapidly in the experiments which are most successful in producing embryos, and I am inclined to think that they are enemies of the embryo. To a certain extent, the strength of solution governs which sort is to develop. Thus, an amœboid flagellate develops in the weaker solutions of Expt. 74. (This and other infusoria I was unable to identify, owing to lack of literature on the subject.) Monads developed in the strong solutions of Expt. 73, etc. In Obs. 5½, an infusorian, shaped like an exclamation point (which swims with an unusual motion for an infusorian), is noted. But the more usual enemies are two species of large ciliates, one very transparent and the other quite opaque. (See Expt. 79½.) These forms appeared new to Professor Lockwood, to whom they were shown one day when he visited my laboratory. When the solutions contain dead and decomposing matters only, they give way to other species, which are scavengers rather than parasites. The observations recorded in Obs. 21 refer to the non-parasitic forms.

"MUDDING" OF OYSTERS.

Question 2. It is well known to oystermen that if the mud accumulates too rapidly about an oyster it fails to keep its shell clear, and the result is suffocation. Biologists also know that a very thin film of sediment upon a newly-fixed oyster is fatal. It is sometimes stated that if the shadow of a boat sailing above falls across an oyster-bed, the oysters (if watched) will be seen to close their shells. As the oyster keeps mud and other enemies from invading its house by this sudden closing of the shell, the snapping observations recorded in Obs. 26 and Expt. 90 are of interest. These records *show that the snapping of the oyster is governed by two sorts of nervous action—one by a "reflex," through a stimulus, and one by automatic, rhythmic*

action. In case the mud settles gently the sudden stimulus would be wanting, and hence the usefulness of the rhythmic, automatic closing. The oyster's adductor muscle is sometimes termed the "heart," and in this respect it resembles the heart, viz., in its rhythmic contractions. *The rate of this rhythm is very different for different oysters, and in this fact may be seen the reason why some oysters are smothered while others are not.* It remains to study the effect of different things on this rhythm.

Questions 4 and 5. Attempts were made to fight the infusoria by noting how various solutions affected the embryos and infusoria, as in Expts. 73 and 79½. The outcome of these experiments is that the infusoria are found to be more hardy than the embryos, and are by this means given a new advantage over the latter. It would be interesting to see what the effect would be upon an embryo bred in a river, and either carried out to sea or else subjected to a freshet. For solutions below 1 per cent. there is disorganization of the embryo, and for 3⅓ per cent. a shrinkage. This is simply a physical effect, and experiments must be made by gradually changing the percentage of the solution. Strong solutions seem to have the same effect upon the ciliary movement in producing tetanus ("shivering") as upon the spermatozoa. (Compare Obs. 16 and Expt. 23.)

Question 6. The conditions causing pathological development have been noticed here and there in this report, and need not be again discussed. The subject requires further investigation.

Series F.

SPAWNING-OYSTERS AS FOOD.

Question 1. During my stay in Keyport I frequently indulged in an oyster stew, in spite of the fact that the month was "r-less" and that the oysters eaten were plump with spawn. I never have eaten better oysters before nor since. The oysters used were Southern plants that had been "down on the ground" at Keyport for only two months, and they were more spawny than any other oysters seen. Samples of the lot from which the stews were made were taken to the laboratory and experimented with, successfully to the issue of numerous embryos. These oysters had been freshened and did not keep as long as the others; they quite easily fermented (see Obs. 24), and the

longest kept (0 + 3) (see Obs. 14) had highly deteriorated eggs. To eat such oysters raw or even cooked would be deleterious to health. *But taken fresh* from the beds to the kitchen *none are better.* One should be suspicious of that cytohelminth which is present in June if not earlier, but is gone after the middle of July or sooner. It may be laid down as a fixed principle that during the "r-less" months—May to August—the conditions that tend to make oysters unfit for food are these: (1) presence of parasites, (2) rapidity of deterioration and decay due to conjunction of spawning period, and (3) great heat very much hastened by the process of (4) "freshening." *If oysters are fresh, the presence of spawn is in their favor as an article of food* (at least when served in a stew). Such oysters should be "freshened" by a momentary wash in fresh water after "shucking" and just before cooking.

LEGAL ASPECTS.

Question 2. It is plain that unscrupulous persons and ignorant ones could easily deal in deteriorated stock during the summer months to the jeopardy of the health of the city and inland consumer. To remedy this, laws have been enacted, now largely repealed at least by custom, forbidding the taking and sale of oysters during these months. Undoubtedly these laws, so far as they relate to the natural beds, are of incalculable benefit in preserving these beds (to the extent they have been preserved). *But the planter stands in relation to his crop just as a farmer does, and should not be prevented from handling it as he thinks for his best interests and the best interests of the consumer. If properly regulated, the business of furnishing summer oysters is of benefit to all.* The public, and especially the dealers and inspectors, should understand just what a wholesome oyster is, and then this food can be dealt with as other meats are, such as fish, beef, &c. It is more difficult to ascertain the quality of an oyster than of a fish, but not so much so as to judge of mushrooms. This difficulty consists largely in the fact that the oyster is enclosed in a shell, and that after the shell "gapes" the contents can easily be mingled with other stew oysters and the act thus escape detection.

Series G.

TECHNICAL.

Question 1. A comparison of Expts. 43, 50, 51, 64, 84 and 85 shows that it is possible to separate eggs by stratification into lots that differ in the proportions of the various grades of eggs present, according to weight, but none of the experiments show how such separation can be made absolute, nor how weight is related to ripeness. In this I was disappointed, but hope some means of ascertaining the relative numbers of eggs of different sorts present in the gonad may be discovered in future studies. On the successful accomplishment of this depends the solution of other questions, such as "Are all the eggs ripe at once?" "How long does it take an oyster to spawn?" etc. We need not make a detailed study of those experiments which seek to separate eggs into those falling first, later (five minutes), etc., and the suspended residue. These experiments are complicated and the results obscure.

Question 2. With regard to the embryos the question is more easily answered. We saw above that embryos come to the surface after one-half or three-quarters of a day, and unless the temperature is high and development rapid, they remain at the surface for a day longer. The pouring off of the surface of the water in the breeding-glasses at the close of the first day of development secures the best of the embryos. Curiously, a large number of embryos remain below, rotating among the undeveloped eggs, with no other sign of imperfection. The above two questions, although amply represented by experiments, require a more systematic investigation than was given last summer.

Question 6. Without some means of keeping the water of proper temperature, properly aërated, and of preventing the development of infusoria, and finally of feeding the oyster, it is impossible to keep oysters in limited supplies of water any longer than if kept out of the water. See Expts. 27 and 90.

Question 7. According to Expt. 64, the most numerous embryos resulted from using the most concentrated solutions of spermatozoa, a result surprising to one who realizes the countless numbers of spermatozoa produced to each egg, and that only *one* is needed for fertilizing an egg. A series of highly instructive experiments is pos-

sible in this connection, showing how age, etc., affects the ability of the sp. to find the micropyle, or possibly how the sexual attraction is influenced by various agencies.

MISCELLANEOUS.

Expts. 79 and 81, although somewhat contradictory, show that the sheltering of a portion of a gonad from evaporation, bacteria, etc., resulted in partly counteracting the weakening effect of post-marine age.

Oysters used early in the season appeared to have greater vitality than those whose spawning was delayed. In many cases the eggs were partly or wholly decomposed, rather than truly spawned out, or even partially so. This agrees with the experience of the Connecticut planters, who raise seed upon their cultivated beds, that the "cultch" should be in place before the middle of July to secure a good set. The main spawning is done soon after the first few days of July, and of course for our latitude and location somewhat earlier. (As I go to press (June, 1891), additional experience gained from a set of Virginia experiments tends to somewhat modify the strictness of these statements. This will be discussed in our next report.)

The spawning season may be considered to have lasted from the middle of June to the 7th of August, but the belated spawners seemed to lack greatly in vitality as compared with the earlier ones.

TABLE IX.—Showing Viability of the Spermatozoa in Different Solutions of Sea-Water.

ABBREVIATIONS.—a = active; s = slow; d = dead; l = length of life (motion); sh. = shivering. The figures in the per cent. columns designate the minutes elapsing from time of infusion to the observation. The abbreviations give the condition of the sp. at such times. See pp. 295, 299.

Experiment number.	Length of time out of water. No. of days unopened.	Length of time out of water. No. of days after opening.	No. of oyster.	One-half per cent.	Two-thirds per cent.	Three-fourths per cent	One per cent.	One and one-fourth per cent.	One and one-third per cent.	One and one-half per cent.	One and two-thirds per cent.	Two per cent.	Two and one-half per cent.	Three per cent.	Three and one-third per cent.	Three and three-fourths per cent.	Four per cent.	Remarks.
60	0+	0	54									45 a., 195 s.						Eggs of No. 55 (0 + 0) present.
61	“	“	54									340 l.						
64	“	“	56									120 l.						With egg No. 57 (0 + 0).
1 & 2	1+	0	4				75 a., 90 a.											
30	“	“	18										30 a., 47 a.					Sp. have latent period.
31	“	“	19										17 s.					
33	0+	1	37								180 s. 285 d.							
42	“	“	37								265 d							98 degrees Fahr.
57	“	“	47				30 a., 135 s					135 a.		135 s.				Sp. have latent period.
66	“	“	53									120 l.						With eggs of No. 59 (5 + 0).
67	“	“	53									195 a. 270 d.						
68	“	“	53 & (61)									105 l.						With eggs No. 60 (5 + 0).
8	1+	1	4											Soon s.				
11	“	“	12	10 l.		15 l.	22 s.			25 a.		30 a., 100 d.	35 s., 100 d.					
12+13	“	“	12			10 a. 40 d.	35 l.											
74	0+	2	53									30 a.						With latent period.
80	“	“	67	15 d.	15 s. 60 d.		15 s., 60 d.		15 a 60 s.			60 a., 120 s. 180 l.			15 d.			With eggs of No. 68 (0 + 2).
62	0+	3	47									60 l.						With eggs of No. 46 (0 + 3).
16	4+	0	14	30 s., 120 l.			35 a., 180 s.	38 a., 133 s.			135 a.		137 s.	20 a., 30 s.				
63	2+	2	49 + 51									45 l.						With eggs Nos 48 & 50 (2 + 2).
69	5+	0	61									90 s., l.						With eggs No. 62 (5 + 0).
70	“	“	61									165 a. 240 d.						
71	“	“	61									60 l.						With eggs Nos. 63 & 64 (1 + 0).
18	4+	1	13 + 14			5 s.	10 l.				17 s. 25 l.		25 a., 30 s.					90 degrees Fahr.
19	“	“	13 + 14					50 s.										77 degrees Fahr.
20	“	“	13 + 14										Soon s. Soon d.					110 degrees Fahr.
75–77	5+	1	61									30 a.						With eggs Nos. 60 (5 + 1), 65 (2 + 1).
23	6+	0	16			0 l.	0 l.	5 s., 11 d.			82 a.		84 a.	58 a.	84 a.	18 d.	20 sh. 70 sh.	
22	4+	2	13 + 14					15 l.					4 s.					With latent period.
28+29	6+	1	16								20 d.		20 s. 82 d.		20 s. 32 sh. 45 d.			

TABLE X.—Showing Effect of Strength of Solution and Age of Oyster on the Character of the Development.

Experiment number.	OYSTERS UNITED.				CHARACTER OF RESULTS.						Remarks.
	FEMALE.		MALE.		Nil.	Partial.	Poor.	Passable.	Fair.	Good.	
	Age.	Number.	Age.	Number.	PERCENTAGE STRENGTH OF SOLUTION.						
35	0+0	28	0+0	29						1⅔	
36	"	84	"	85						1⅔	
37	"	88	"	85						1⅔	
37½	"	86	"	87						1⅔	
48	"	44	"	42						2	
56	"	46	"	47						2	
65	"	58	"	56						2	
64	"	51	"	56					2		
60	"	55	"	54	2						
78	"	68	"	67		8¾		8⅛	5/13, 2⅛	½–1⅔	
4	1+0	1	1+0	4				1			
46	"	40	"	41	1⅔						
71	"	68+	5+0	61	2						
54	0+1	44	0+0	47		2					
55	"	48	"	47		2					
40	"	28								1⅔	
48	"	88					1⅔				Sp. sluggish.
44	"	28	0+1	29+	1⅔						Weather hottest.
50	"	44	"	42	2						
51–58	"	44	"	42		2					
54	"	44	"	47		2					
58	"	46	"	47	6	1	8⅛		2		
87	"	79	"	81	2						
88	"	84	"	82	2						
32	2+0	20	1+0	18	2½		8⅛			1⅔	
84	"	28	2+0	22				2½			
47, 47½	"	40a	"	41a		2					
59	"	48	"	49					2		
79	0+2	68	0+2	67		2 R.			2 L.		R — right side; L — left side.
80	"	68	"	67	⅓+2		⅔+2		1¼–8⅛+2		Transferred to 2 per cent. after fert.
80	"	68	"	67	⅔, 1, 8⅛	⅓, 1¼, 2					Not transferred.
81	"	69	"	67	2 R.		2 L.				As for Expt. 79.
82	"	69	"	67	2						
85	"	74d	"	78						2	
62	0+8	46	0+3	47	2						
68	2+2	48	2+2	49				2			
66+68	5+0	59+	0+1	58		2					
69	"	62	5+1	61	2						

The numbers in columns 6-11 refer to the strength of the solution in which the eggs were that developed "good," "fair," etc. See pp. 296-303.

TABLE XI.—Showing the Influence of Temperature, etc., on the Rate of Development of the Oyster's Eggs.

For discussion, see pp. 302 *et seq.*

Experiment number.	Female. Age.	Female. Number.	Male. Age.	Male. Number.	Percentage solution.	How soon fertilized.	Stage	Stage III.	Stage VI.	Stage VIII.	Stage IX.	Stage X.	Stage XI.	Stage XIII.	Stage XIV.	Death.	Temperature, degrees.	Remarks.
48	0+0	44	0+0	47	2	0								¾ day.		4 days.	70	Night.
4	1+0	1	1+0	4	1	0	1¼ hr. +							¾ day.			70	Night.
79	0+2	68	0+2	67	2	0		3 hrs.									74	
56	0+0	46	0+0	47	2	0								¾ day —		3 days.	76	Night after first 3 hours.
78	"	68	"	67	½-1	5						2¾ hrs.					76	
78	"	68	"	67	1½-2½	30						2¼ hrs.					76	
78	"	68	"	67	3¾-5	5						2¾ hrs.					76	
68	2+2	48	2+2	49+	2	0		2⅔ hrs.						¾ day.			76	
58	0+1	46			1	0				3¼ hrs—(dead).							78	Max. temp. for early part of expt.
58	"	46			1	15				3¼ hrs—(dead).							78	
58	"	46			1	30				3¼ hrs—(dead).							78	Max. temp. for early part of expt.
58	"	46			2	0		1¾ hrs.					3¼ hrs.			2 days.	78	Max. temp. for early part of expt.
58	"	46			2	15		1¾ hrs.					3¼ hrs.			2 days.	78	Max. temp. for early part of expt.
58	"	46			2	30		1¾ hrs.					3¼ hrs.			2 days.	78	Max. temp. for early part of expt.
58	"	46			3	0	2¾ + ?				3½ hrs.						78	Max. temp. for early part of expt.
58	"	46			3	30					3½ (sick).						78	Max. temp. for early part of expt.
37	0+0	38	0+0	35	1⅔	0-30								10 hrs. —			80—	Night.
37½	"	36	"	37	1⅔	0								10 hrs. —			80—	Night.
66	5+0	59	0+1	58	2	0						5 hrs.					80+	Max. temp. 84°.
36	0+0	34	0+0	35	1⅔	0		1½ hrs.									81	
35	"	28	"	29	1⅔	0			1 hr.		1½ hrs.		2¼ hrs.	3 hrs. +	¾ day.	1¾ day.	82	
68	5+0	60	0+1	58	2	0					4½ hrs.						82+	Max. temp. of 84°.
35	0+0	28	0+0	29	1⅔	0		½ hr.								1½ day.	90-100	For first few hours.
Brooks's observations							2 hrs.	2½ hrs.	3 hrs.	3½ hrs.	4 hrs.	4 hrs. ?	4 hrs. ?	1 day, 24 hrs	2 days.	6 days.		

TABLE XII.—Showing the Factors affecting the Viability of the Eggs of the Oyster.

Experiment number.	Age.	Number.	Grade of results in development. Good.	Fair.	Passable.	Poor.	Partial.	Nil.	Time eggs left in solution before fertilization.	Remarks.
			Percentage strength of solution.							
37	0+0	38	1 2/3						5–15	Transferred.
78	"	68		5/13–1			3 3/4		5–15	"
64	"	57		2					5–15	"
54	0+1	44					2		5–15	"
48	"	38				1 2/3			5–15	"
58	"	46					1 and 2	6	5–15	"
80	0+2	68		1–3 1/3		2/3		1/2	5–15	"
80	"	68					1/2–3 1/3		5–15	Not transferred.
37	0+0	38	1 2/3						25–35	Transferred.
78	"	68	1 2/3	5/13–4/7, 2 1/2		3 1/3, 3 3/4			25–35	"
40	0+1	28	1 2/3						25–35	"
50	"	44						2	25–35	"
58	"	46		2		3	1		25–35	"
78	0+0	68	1–1 1/4	1/2–4/7, 1 2/3–2 1/2	5/13	3 1/3–3 3/4			75	"
80	0+2	68			1 1/3–3 1/3		1/2–1		75	"
78	0+0	68		1			1/2, 1 1/4–1 2/3	5/13, 4/7, 2 1/2–3 3/4	90	Not transferred.
80	0+2	68					1 1/3–3 1/3	1/2–1	135	Transferred.
80	"	68					1 1/3	2–3 1/3	135	Not transferred.

The figures in columns 4–9 refer to the percentage of saltness of the artificial sea-water in which the eggs were that gave the grade of results indicated by the different columns respectively. See pp. 296–301.

TABLE XIII.—Showing Effects of Age, etc., on the Eggs.

ABBREVIATIONS.

Unch. — unchanged; swol. — swollen; ves. — vesicular; irr. — irregular: shr. — shrunken; gr. — granular; pt. segtd. — partly segmented; path. — pathological; emb. — embryos; decom. — decomposed; sol. — solution; s. — some; f. — few; m. — many; fert. — fertilized; aft. — after; ex. — examined; trans. — transferred to sea-water when fertilized; segtn. — segmentation.

Experiment Number.	Age.	Number.	Solution of less than one per cent.	One to two and one-half per cent., usually sea-water.	Solution stronger than two and one-half per cent.	Fertilized or not.	How soon fertilized—hours.	How soon examined—hours.
87	0+0	88	....	Round in ¼ hour.	....	Not fert.	....	Soon.
60	"	55	....	Decomposed.	....	Fert.	Soon.	8
65	"	58	....	M. round; m. emb.	....	"	"	14
56	"	46	....	M. round; m emb; m. path. emb.	....	"	"	72
78	"	68	Segtn. pt. path.; trans.	Segtn. normal.	Segtn. pt. path.; trans.	"	½	8
78	"	68	Segtn. pt. path.; trans.	" "	Segtn. pt. path.; trans.	"	1¼	8
78	"	68	segtn. f. partial; trans.	Segtn. partial.	S. round; no segtn.; trans.	"	2¼	8
71	1+0	68	....	Decom.; irr.	....	"	Soon.	8½
43	0+1	88	....	Most round; f. pt. segtd.	....	"	½	11
44	"	M.	....	Decomposed.	....	"	Soon.	11
58	"	46	....	Pt. segtd.	Pt. segtd.	"	"	8½
58	"	46	....	Decomposed.	....	"	"	48
64	"	57	....	M. irr.; m. round; f. emb.	....	"	"	14
50	"	44	....	S. unch.; m. round.	....	"	½	8¼
58	"	46	....	Decom.; f. pt. segtd.	Path. emb.; trans. 4 hrs.	"	½	48
84	0+2	74	....	Round; swol.; ves.	....	Not fert.	....	Soon.
85	"	74	....	Round; pt. segtd.; emb.	....	Fert.	Soon.	22
80	"	79	Round; swol.; decom.; gr.; trans.	M. round; s. pt. segtd.	Swol.; round.	"	2¼	20
80	"	79	Round; swol.	Swol.; round; pt. segtd.	....	"	2¼	20
80	"	79	M. round; m. swol.; s. pt. segtd.; trans	M. round; s. unch. M. swol.; pt. and path. segtn.	M. round; m swol.; s. path. segtd.	"	1¼	20
80	"	79	Round; swol.; trans.	M. round; m. pt. segtd.; s. emb.	Segtd. and emb.	"	¼	20
80	"	79	M. round; s. vesic.	M. round; s. swol.; s. pt. segtd.	M. vesicular.	"	¼	20
79	"	68	....	M. round; s. swol.; s. segtd.; s. emb. M. swol.; m. round.	(Left.) (Right.)	Fert.	Soon.	17
81	"	69	....	M. shrunken.	....	"	"	24
62	0+8	46	....	Decomposed.	....	"	"	1
63	2+2	48	....	M. decom.; f. shr.	....	"	"	"
63	"	48	....	F. emb.; m. path. emb.	....	Fert.	Soon.	15
69	5+0	62	....	Decom.; shr.	....	"	"	4
24	6+0	17	Opaque; gr.; irr.; vesicular.	Unchanged.	Gr.; shr.; irr.	Not fert.	"	Soon.
26	"	17	....	Round.	....	Fert.	"	"

For discussion, see pp. 296-303.

§ 11. *Summary of Conclusions.*

We made no pretense of studying any portion of the embryology of the oyster, but confined ourselves to a consideration of the effects of different conditions of environment upon the sexual cells before fertilization, and during early development. Our series was not completed, being notably deficient in the records concerning temperature. We herewith present a systematic summary of the conclusions reached from a study of the summer's records, as presented in detail in the preceding pages.

TEMPERATURE AND SPAWNING.

(1) From the latter part of April until June, the temperature of the water upon the oyster-beds at Perth Amboy, Keyport and Oceanic rose steadily from about 50° Fah. until it reached 70°, June 1st, in the Shrewsbury river, and in Raritan bay about the middle of June.

(2) From this time on during the spawning season the temperature fluctuated between 70° and 80°.

(3) Spawning began upon the respective beds very soon after the temperature reached the seventies.

(4) Seed obtained from the more northerly beds spawned first, and finished spawning relatively early.

(5) Seed from the Chesapeake region spawned later, and was the last to show spawn.

The supposed evidence for the belief that the same oyster may repeat the spawning process more than once in a season was found insufficient.

(7) No oysters were found in which all the eggs were capable of developing. (Perhaps 70 per cent. represents the most fruitful result obtained.)

(8) Seed which matures its sexual cells early produces more fruitful results in vigor and relative number of offspring than the later spawners of the same kind of seed.

(9) After August 7th, at Keyport, the spawning proper had ceased; only young Southern plants showed traces of spawn after this date.

PHYSIOLOGY OF OYSTERS.

(10) Oysters removed from the water and left dry at ordinary summer temperatures remain closed for about a week.

(11) When oysters begin to fail in the power of holding the shell closed they are not dead, for a stimulus will cause closure for a short time.

(12) Such oysters are partially spoiled (through fermentative action of bacteria), and are unfit for food.

(13) After this point of weakness is reached the death of the oyster is rapid. One day later, it fails to respond to stimulation.

(14) Freshening oysters increases very rapidly the rate of weakening and decay of oysters. (The life-period is reduced one-half.)

(15) After an oyster is opened the death is rapid and in proportion to the length of time the oyster has been out of water.

(16) If oysters be placed in limited supplies of sea-water the post-marine life-period is not lengthened, owing to the breeding of infusoria and bacteria in the water.

(17) Oysters open and shut their shells according to a rhythmic or automatic law (while "breathing").

(18) Oysters differ greatly in the rapidity of this rhythm of respiration (the object of which is to clear the external gill or mantle cavity of mud). See Expt. 90.

PARASITES.

(19) Several species of infusoria are parasitic in the stomach, etc., of the oyster, but are not abundant enough to be taken account of in culinary interests.

(20) During the early portion of the spawning season there is abundantly present, in a large proportion of oysters, an infusorial parasite (average length $\frac{1}{800}$ inch), termed by us "cytohelminths" (worm-like cells). (See note at close.)

(21) These cytohelminths are bred in a structure which is, or resembles the "crystalline rod," a flexible, gelatinous structure, shaped like a nematode worm, about an inch long, and situated in a loop of the intestine known as the "pyloric" portion.

OYSTER ECONOMICS.

(22) Oysters that are ready to spawn, if cooked soon after removal from the sea-bed, are extra good and palatable food.

(23) Oysters in spawn deteriorate more rapidly than at any other season, at the same temperature.

(24) The warmth of summer acts upon oysters as upon other meats, especially fish, to produce rapid decay.

(25) Oysters in market should be under stringent inspection.

(26) Oystermen should not be required to freshen oysters; this should be done by the caterer just before cooking or serving.

(27) Oystermen should not be hampered by laws limiting the times or manner of taking or selling oysters.

THE SPERMATOZOA.

(28) Spermatozoa removed from a ripe male oyster and infused into sea-water, begins a very active dancing motion, either at once or after a "latent period" of a few minutes.

(29) The length of time an oyster has been out of water often determines whether a latent period is present. (Post-marine age in proportion to its length tends to produce this period.)

(30) The spermatozoa survive the death of the oyster for a period inversely proportional to the length of time which has elapsed between the taking of the oyster from its bed and the artificial opening of the same.

(31) The activity of the spermatozoa lasts during a period whose length depends on whether a latent period is present or not, the post-marine age of the oyster, the density of the water, the temperature, the presence or non-presence of eggs, the age of the eggs if present, and whether the oyster has been freshened or not.

(32) Oysters with latent period have spermatozoa with decreased periods of activity.

(33) Fresh spermatozoa in their native sea-water are active over five hours.

(34) This period is shortened in proportion to the post-marine age, in which (*a*) the number of days before the oyster is opened count as nearly equal in influence to (*b*) those that have elapsed since the oyster was opened. (By the end of a week the period is reduced to a

quarter of an hour, but (c) conditions of temperature and moisture affect the result. The above experiments were performed upon oysters subjected to an average of 75° Fah., and moderately shielded from evaporation after opening.)

(35) Densities of salt water above 2 per cent. shorten the active period to about a quarter of an hour when 3⅛ per cent. is reached.

(36) Densities weaker than 1⅝ per cent. (or thereabouts) shorten the period to the same extent when one-quarter per cent. is reached.

(37) Post-marine age tends to shift the optimum strength of solution up the scale. For oysters nearly a week old the optimum is above 3 per cent. instead of being below 2 per cent., as for fresh spermatozoa.

(38) Increase of temperature increases the activity, but shortens the period. The practical limit (a period of a few minutes' duration), is reached between 100° and 110° Fah.

(39) The optimum temperature for spermatozoid activity lies, roughly estimated, at 85°. (Lower limits not yet ascertained.)

(40) When spermatozoa are infused into water containing eggs their activity is increased, but the period is shortened one-half.

(41) The fresher the eggs the greater their effect in shortening this period, but the two parts of post-marine age, viz., the days before opening and the days after opening, have unequal influence. Days after opening have less effect to shorten the period than days before opening.

(42) Freshening of oysters reduces the vitality of spermatozoa.

(43) The ability of spermatozoa to fertilize eggs decreases with post-marine age, and after two or three days the results are no longer satisfactory, although development is caused for some time later, yet this development shows a gradually descending scale of power as age increases.

(44) In two or three days the active period of spermatozoa is reduced one-half; it follows that spermatozoa can suffer a weakening of 50 per cent. of their vitality before losing the power to cause at least fair results in fertilization and development.

THE EGGS.

(45) Eggs are, at every point where environment influences them, more sensitive than spermatozoa.

(46) Eggs do not survive the death of the oyster unless the oyster be opened fresh.

(47) In oysters over two days old the eggs fail to produce embryos but rapidly decompose in the sea-water (oyster still alive).

(48) Fresh eggs, unfertilized, remain in sea-water for several days before yielding to decomposing forces.

(49) In solutions weaker than normal and in proportion to the dilution, fresh eggs decompose rapidly, passing through stages of swelling.

(50) In solutions stronger than normal, fresh eggs shrink, and finally also decompose with rapidity.

(60) Freshening of oysters acts very strongly to produce deterioration of eggs. Sometimes the eggs are as far gone when the oyster is first received as if the oyster (unfreshened) had been kept over two days.

(61) Eggs in oysters of only one day's post-marine age show (*a*) a great decrease in the number of eggs fertilizable, and (*b*) a partial and abortive development.

(62) Fresh eggs can remain in normal sea-water over an hour before fertilization without losing the power of being fertilized and of developing.

(63) Some partial and abnormal development takes place even after two and one-quarter hours' soaking before fertilization.

(64) Solutions weaker or stronger than normal (*a*) decrease the period eggs can remain unfertilized without deterioration, or (*b*) if the period be the same, the results in development are correspondingly unsatisfactory, poor or *nil.*

(65) Temperatures favorable to development range from 70° to 100°, with a probable optimum near 85° Fah.

(66) Increase in temperature rapidly increases the rate of development by about double for every ten degrees.

EMBRYOS.

(67) Embryos cannot be readily kept to the time of fixation without the assistance of a claire to furnish food.

(68) Embryos seem to be attacked by the infusorial parasites from the stomach, etc., of the adult oyster.

(69) At average temperatures vigorous embryos are all at the sur-

face from one-half to three-quarters, or one day, and can be readily separated from debris and sediment at such time.

(70) Many embryos fail to become free-swimming.

(71) No satisfactory way of separating good eggs from bad ones in oyster culture was discovered.

(72) Eggs sink in sea-water at a rate of nearly a foot per hour. (This can be taken advantage of in cleaning eggs by stratification.)

(73) Spawn is dispersed mainly by tidal currents during the short period the embryo swims at the surface.

(74) (*a*) The temperature of the water at Keyport was favorable to a set as judged by our records and experiments, and (*b*) a set was reported to have occurred—the first for many years.

(75) The saltness of the water at Keyport is close to the upper extreme of density for oyster culture, and can be weakened to one and a half per cent., if not lower, without producing any unfavorable results so far as a "set" is concerned.

(76) Embryos are more delicate than their infusorial enemies.

(77) Embryos do not stand a sudden transfer into water weaker or stronger than 1½ to 2 per cent. without being greatly weakened.

In the above summary we have used figures wherever an approximately accurate result could be inferred from our experiments; but much work will be required to make the series complete and the figures accurate. The number of forces that influence the result is often so great that the analysis becomes difficult and tedious. We believe this labor is well bestowed, in view of the scientific and economic bearings of these questions.

Note on the Cytohelminths.—Prof. Lockwood referred me to an article, "Protozoan Parasites of the Oyster," by Prof. John Ryder, in *Science*, Vol. I., p. 567, June, 1883, in which there is a description of a parasite named *Spirillum ostrearum*, by Prof. Ryder, supposed to be the *Trypanosoma Balbiani* of M. Certes, which is undoubtedly the same as our cytohelminth. Observations this season have confirmed our view of the relation of this form to the crystalline rod, or "jelly-worm," as the oystermen call it. This jelly-worm is fixed by a larger head end to the walls of the stomach, and after making a twist or two in this cavity, the rest of the body occupies the entire lumen of the pyloric portion of the intestine, to its turning-point, between the muscle and gills. The gelatinous structure of this

"worm" is homogeneous; that is, it is non-cellular, but it is firmer on the outside than within, where it shows a "lymph," filled with fine granules, in which swim numerous cytohelminths. In the firmer cortex, the cytohelminths cork-screw their way in a direction mainly transverse to the long axis of the spore sac, becoming fewer and fewer as the surface is approached. At the extremities, at least, of this sac, these parasites swarm out and live freely in the intestinal chyle, even before the "nurse" decomposes. This jelly-worm rapidly liquefies a few hours after the oyster is removed from the water, setting free all the young. It is not yet certain that this form is a *Trypanosoma*, and still less that its specific name should be *Balbiani*. It is certain that it is no *Spirillum*, but the *ostrearum* portion of Prof. Ryder's name sounds appropriate. It would be well to ferret out its whole life history before deciding what it is. Its vibratile frill is, as Ryder states, spirally disposed about its body, at least while in its nurse.

Note on Microscopes.—At the request of several oystermen, I have examined some of the cheaper microscopes of Queen & Co., 924 Chestnut street, Philadelphia, to see which ones would be adapted for use by them in oyster culture. No instrument cheaper than No. 3063, "The Universal Household Microscope," with powers ranging from 30 to 175 diameters, price $7.50, can be recommended. A better instrument is No. 3090, "The Physiological Microscope," which, without the one-fifth objective, costs $12.

The instrument used by the investigator was a Leitz No. IV., imported from Europe. A form of this instrument, No. 9 (23), giving powers ranging as high as 600 diameters, is furnished by the "Educational Supply Company," 6 Hamilton Place, Boston, for $32. But we used only the lowest objective and highest ocular furnished with this instrument. A magnifying power ranging between 75 or 100 and 150 to 200 diameters is suitable for oyster-breeding work; and it requires only the addition of a watch crystal and a "filler," such as goes with a fountain pen, to complete the outfit.

The Johns Hopkins University Press, Baltimore, has just issued a work on the Oyster by Dr. W. K. Brooks, which should be in the hands of every oyster cultivator; price, $1.

These recommendations are made because my experimental work will be greatly facilitated by the intelligent co-operation of the oystermen.

JULIUS NELSON.

REPORT OF THE BOTANICAL DEPARTMENT.

REPORT OF THE BOTANICAL DEPARTMENT.

BYRON D. HALSTED, SC.D., BOTANIST.

The work during the past year has been along various lines. Some of it was a continuation of that of last season, as with the cranberry scald and the sweet potato rots, while other investigations began during the year covered by this report. The warm winter of 1889–90, and the failure of the peach crop, led to an investigation of the causes of the disaster. The subject of pollen and the influence of wet weather at blooming-time is reported upon. An unusually wet season probably had much to do with the prevalence of many fungi injurious to crops. An account of a study of these forms a considerable portion of this record of results. Much work has been done upon the weeds of the State, including a listing of them with both botanical and local names. A reference list of the various common names, and two dozen page plates of the worst weeds, are also given. Three bulletins have been issued from this department during the year, namely, "Some Fungous Diseases of the Spinach;" "Some Fungous Diseases of the Sweet Potato," and "The Black Knot of the Plum and Cherry Trees."

OBSERVATIONS IN PEACH ORCHARDS.

On April 22d, shortly after it was evident that there would be a short peach crop, if not a total failure, a special bulletin was sent to many of the prominent peach-growers in the State. The following is the substance, and in part the language, of the circular:

"'Test seasons,' as they are sometimes called, give the measures of extremes, and by these we learn the capabilities of cultivated plants. The winter now past was one of exceptional warmth and moisture; many plants were thereby forced into activity, and some of them developed blossoms prematurely. It was no uncommon thing to gather wild flowers in January; but, of most interest to the fruit-

growers, the peaches and pears pushed their blooms at a time when the ground should normally have been frozen. Instead of a good ice crop there was a spring-like warmth in February, with its attendant blossoms, which, while the mercury did not fall to zero in the State, the tender, half-opened buds were blighted. It is too early now to predict what the crop is to be, but, from examination of a large number of buds sent in from various localities, it seems quite certain that the harvest must be small.

"But it should be borne in mind that from a season like the one before us there may come a rich harvest of facts, if attention is only directed to the gathering of them.

"It is, therefore, the purpose of this brief bulletin to call the attention of peach-growers to the importance of this season as a time for obtaining information that, if put in use, may possibly aid them materially in the future.

"It is designed that the grower shall study the questions herein presented, and set down the answers from time to time, as it is possible to do so, and submit the report at the close of the season. These results, tabulated and otherwise brought together, it is hoped, will throw some more light on the importance of culture and exposure, age and vigor, and varieties of trees, etc. Some of the questions, as those relating to soil, drainage, exposure and age of trees, can be answered at once, but the fruitfulness of varieties and other matters are to be determined later in the season.

"1. What is the size of your orchard in acres? In number of trees?

"2. The age of the trees?

"3. The soil and subsoil?

"4. State the kind and quantity of manure used.

"5. Is the land well drained? Naturally, or artificially?

"6. What is your tillage or cropping of the orchard?

"7. What is the 'lay of the land,'—level, or sloping? And if a hillside, what is the exposure to the sun?

"8. What natural protection, as forests, hills, etc., does your orchard have? Anything from hedge or high board fence?

"9. What varieties are grown?

"10. To any particular tree was there more harm done upon one side or in one portion than another?

"11. Did the injury extend beyond the flower buds?

"12. Did you notice that age of tree had any influence?

"13. Was there any advantage in the tree being vigorous?

"14. What character of soil was best for the trees?

"15. What exposure of sun, that is, slope to north or south, etc., is best in a warm winter? In a cold winter?

"16. Does underdraining have any effect?

"17. Will belts of trees, high hedges, forests, hills, etc., assist in protecting the peach?

"18. What varieties were least harmed?

"19. Can you state at least three conditions that combined to harm your peach buds?

"20. Please state any observed facts not given in the above answers."

The first three questions were asked for the purpose of obtaining the basis of facts to assist in using the answers to the succeeding questions. To No. 4, as to the kind and quantity of manure used, the answers were various. Some had used no manure; others applied barn-yard manure liberally. In a few cases it is stated that the manure was spread only under the tree. Ashes, twenty bushels per acre, were often used. Others add ground bone, two to four hundred pounds per acre. Kainit is mentioned; two hundred pounds per acre. Others apply bone-dust, and occasionally one uses all that have been mentioned, but in different years.

The answers to No. 5 are nearly all to the effect that the peach orchard was naturally well drained. Several announce that underdraining is important if the soil is naturally wet, but usually conclude that peach trees should not be set on drained land, and, of course, never upon soil that is still wet enough to require draining. A number state serious losses that have come from excess of water, and trees with "wet feet" are not uncommon.

No. 6 is variously answered. Some grow corn in the first, and buckwheat the second, year, and then devote the land to the peach trees. Some grow garden truck indefinitely, as tomatoes, potatoes, etc. Corn is grown the first three years by some. The average treatment is about three years of hoed crop, or buckwheat one season, and afterward clean culture.

No. 7. About 25 per cent. of the orchards slope to the southward. This question bears directly upon question No. 15, which deals with the effects of exposures.

No. 8. The majority of the orchards were without forest or other protection.

No. 9. Fully seventy-five varieties are named. Of these, the Smock, Crawford's Late, Reeves, Pride of Franklin, Selway, Morris' Rare Ripe, Old Mixon, President and Mountain Rose, are among those the most generally grown.

No. 10. Nearly all gave a negative answer, but some found the natural fruit bore the frost best, and one stated that the yellow-fruited sorts were the hardiest.

No. 11. As a rule, the injury did not extend beyond the buds, but in some cases the upper ends of the branches suffered.

No. 12. Age did not make a constant difference in the effects. The following are some of the expressions upon this point: "Young, vigorous trees least affected," "Oldest hurt the most," "Three-year-olds hurt the most," "The older the tree, the more harm done."

No. 13. The general opinion is that vigor assists in a trying season, but it does not save the buds in an extreme case like the past year.

No. 14. The soil should not be over-rich when the trees are set. The following are some of the expressions used for the best soil: "Clay loam, not wet," "Loam with clay bottom," "Moderately stiff, sandy loam," "Sandy gravel, loose clay bottom."

No. 15. As to exposure to sun, etc., there is a wide difference of opinion, as the following quotations will indicate: "Unprotected exposure is the best," "There is no difference," "South exposure bad," "Northern exposure for both warm and cold winters," "Northern exposure best in warm winters, and southern superior when the winter is mild," "Northern exposure preferred," "Northwest and west in all winters."

Among the more lengthy replies, there is a predominance of evidence in favor of a northerly exposure. As a rule, probably, it is not the absolute cold of winter that kills the buds. It certainly was not a severely cold winter that caused our last peach failure.

No. 16. Underdraining improves land, but, as a rule, peaches do best upon land that is naturally dry. Several state that peach trees should not be set on land requiring underdraining to keep it in good condition.

No. 17. A number pronounce against wind-breaks, and state that peaches are most secure in winter when there is a free circulation of air. Others believe belts of shielding trees are valuable, even "very essential," during the chilling blasts of winter and early spring. Hills and forests may protect when hedges and high board fences are of no service.

No. 18. Under the head of what varieties were the least harmed, not much information was obtained, because the failure was so universal. As a rule, Stumps and Rare Ripes are among the surest. Morris, Smock, Selway and Old Mixon were also named as hardy. It is interesting to note that the early Alexander variety in some orchards was the only sort that set fruit. In Mr. White's, for example, all trees of this variety set full, but, strangely, all the fruit rotted

upon the limbs before fully grown. It would be interesting to know whether the same results obtained elsewhere in the State.

No. 19. It was generally agreed that the excessive autumn rains, warm winter, cold snap on March 5th to 8th, and frosts of April 18th, were the chief reasons which combined to ruin the peach crop the past season.

MICROSCOPIC STUDY OF PEACH BUDS.

It became evident before the winter of 1889–90 was half gone that the exceptional season would have a marked effect upon the peach tree, as it is one of our most susceptible of fruit plants. Twigs, and especially the buds, were subjected to microscopic examination from week to week during the second half of the winter. Twigs were obtained January 3d from a number of growers, and at that time the buds were manifestly swollen, but otherwise no serious injury had been done to them. There was nothing that could have been called real cold weather until March 6th. During the week following that date a large number of buds were examined. Those from some places were all dead, while others contained a small percentage of living buds.

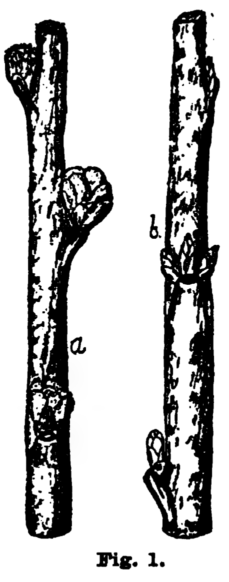


Fig. 1.

By the aid of Figure 1, *a*, it will be able to show the outward appearance of the average peach buds in New Jersey during the middle of March. The figure is drawn from nature, and represents a portion of a twig with three of its buds, with the scales shown much loosened from one another. Such buds when pinched have a soft feel, and not the firmness characteristic of a well-preserved peach bud in mid-winter. In looking down into these buds, the rose color of the infolded petals could often be seen, and occasionally the yellow of a well-developed stamen. Some of the more advanced buds were in full bloom. In order that the changes in the buds due to the warm, moist winter may be more evident, a portion of a twig, *b*, with the buds in the normal condition, is placed alongside of the one showing the forced buds.

Longitudinal sections through the buds show something of what has taken place in the prematurely developed buds. At *a*, in Figure 2, is shown a section through a bud, as found in January of an ordinary winter. The bud scales overlap each other closely, and inclose all the more tender parts that go to make up the blossom. The pistil that is to develop into the fruit occupies the center, and is a somewhat flask-shaped body, while next to it are the floral parts to which the stamens are attached. The stamens are small and almost

Fig. 2.

colorless. Turning now to *b*, which represents a section through a half-opened bud, it will be seen that there is very little change in the pistil. This portion is the last to be affected by the modifying circumstances, but the scales are wide open at the top, the stamens have enlarged remarkably, and it is to their development that much of the opening out of the scales is due. It is only necessary, at this time, to call attention to the fact that the stamens are organs for the production of pollen, and this flower dust is only used to stimulate the receptive pistil into new life. And, while the growth of the pistil is mostly after fertilization, it is, however, true that during the time when it is receptive to the pollen it is most susceptible to cold and other conditions, and it is the portion of a peach bud that first manifests injury from frosts or other exposure.

The inference is natural that cold can get into an open bud much

more easily than a closed one, but we need to look back of the visible differences to the vital conditions. Vegetable tissues in active condition are less able to bear extremes of heat and cold than those in a quiescent state. A seed, for example, that is dormant will bear the conditions without injury that would kill it if germination was taking place. The delicate structure at the center of a flower not only needs to be kept, by the infolding bud scales, from being exposed to the elements, but, most of all, it requires that an inactive condition within itself shall prevail. A well-prepared bud is like a seed, and becomes most susceptible to sudden changes only when it is unfolding or preparing to grow. It is not so much the opening of the bud scales as the growing condition within, resulting in the unfolding, that permits the dangerous results.

The pistil is the part first to show that the flower bud is blasted and worthless. The green, fresh appearance is replaced by brownness, and the former plump, upright organ becomes shriveled and drooping. In Figure 3, at *a*, is shown a healthy pistil, as seen in a live bud. To the right, at *b*, is another pistil that has recently been killed and was turning brown. The stamens are the next to change in the same way, from the normal color to the brown of death. The other less vital organs of the blossom finally die, and after a short time become a dark and worthless substance. If the bud is not opened, it may require a longitudinal cut of the knife to determine the exact condition, but last winter an ordinary pinch of the swollen bud was enough to demonstrate that all was blasted and worthless within.

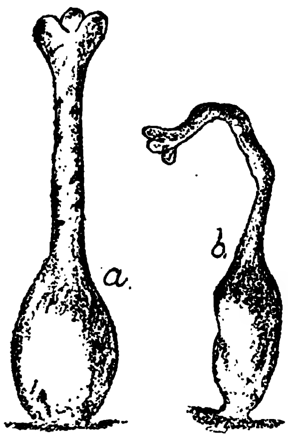


Fig. 3.

The winter of 1889–90 was so sweepingly bad for peaches that some of the facts looked for could not be obtained. For example, it was hoped to learn which buds upon a twig—that is, high, medium or low—were the best able to survive, and as none lived, the strongest were not left to indicate their superior endurance. It was at the outset hoped to add some points of value regarding the relative hardiness of different sorts, and also the advan-

tage of one exposure to sun over that of another, as well as the influence of dark or light soil and the like, but the means for making a practical test of these matters were all swept away by the unusually fatal winter and early spring; therefore the observations need to be continued through coming years.

INFLUENCE OF RAINFALL AT BLOOMING-TIME UPON SUBSEQUENT FRUITFULNESS.

In April of last year a special bulletin was issued upon "Pollen versus Rain," in which directions were given for carrying out experiments with a view of determining the influence of rainfall at blooming-time upon subsequent fruitfulness. The well-known facts were therein stated that during some years fruit trees are barren without any apparent reason, and that the pollen plays an important part in fruit production, and therefore anything that interferes with the action of the pollen may have a direct and substantial influence upon the crop. Unfavorable conditions of the flower dust at blooming-time may therefore be, in a large degree, accountable for the lack of fruitfulness, as, for example, a cold rainstorm at the time when the trees are in full blossom.

As the weather is largely beyond man's control, it is evident that accurate observations as to its character are of much value in this regard, while it is possible to carry out, often with much difficulty and expense, field experiments that may throw light upon the puzzling problem. Thus, for example, advantage can be taken of a dry spell at blooming-time by keeping the plant moist, and especially the flowers, by artificial spraying, for the few days that cover the period of blooming.

With strawberries, for example, the following serves as an outline that was observed in the field experiments carried out by the Station Botanist upon the grounds of Mr. J. M. White, near New Brunswick; the two sorts experimented with being the "Parry" and the "Sharpless." The field was in row culture, and eight-foot spaces in various rows were selected, as nearly uniform in growth, vigor, etc., as possible. One eight-foot space of each variety was kept constantly wet by frequent sprinkling during the period of flowering.

It is well known to fruit-growers that insects are the most active agents in the transfer of pollen, and therefore these first rows were

left uncovered, so that the only difference between them and the field generally was the moist blossoms, provided that the insects visited these latter as willingly as the ordinary flowers. While not able to observe this point to full satisfaction, it is safe in concluding that fewer insects visited the wet blossoms than the dry ones. As a result, at picking-time the crop was manifestly less than the average, and the point to be particularly emphasized is that the berries were very irregular—that is, less perfect or well formed than in other parts of the field. From this experiment, it is evident that berries and crop are injured by keeping the plants wet at blooming-time.

Another eight feet of each variety were kept dry—that is, all rains excluded by a canvas cover placed upon stakes a foot above the ground. Here the berries were the same as in the other parts of the field—the advantage of the continuous dryness, if it is to be considered, being overcome by the probable decrease in the visitation of insects due to the canvas being so near to the plants. There were fewer young berries under the covers, which may be due to the greater dryness, or possibly a difference of temperature for both day and night, may have had an influence. This experiment indicated that it is not profitable to cover the beds with canvas, a result not to be expected and entirely unsought.

The currant and gooseberry are both plants of a size that render them well adapted to experimentation for the influence of weather conditions at blooming-time upon fruitfulness, so far as such matters are subjects for experimentation. The means for excluding the rain need to be more extensive than in the case of the strawberry, and the same may be said of the blackberry and raspberry, and similar small fruits. The grape is a plant that on many accounts is well adapted for the experiments here in mind. The period of blooming is brief, and requires, therefore, attention for only a short time. The covering may be limited to the individual cluster, as the practice of "bagging," which keeps the blossoms dry in wet weather. There is much difference of opinion as to the ability of grape clusters to become fertilized while under the bags, and upon this point some work has been done by the Station, and is still in progress. Sufficient data have been gathered by microscopic study of unopened flower buds to warrant the conclusion that in many cases the pollen is discharged upon the pistil before the cap has been removed. That this be true in all varieties, whether upright or reflexed stamens, remains to be deter-

mined, as several quarts of buds preserved in alcohol are now in the laboratory awaiting opportunity for examination. Even if pollinization is secured before blossoming, that does not destroy the influence of the weather at blooming-time, for it is a well-established fact that, as a rule, pollen of another flower is more potent upon a pistil than that from the stamens of the same blossom, and by means of abundant nectar, grape flowers are adapted for cross pollinization through the agency of insects.

The actual experiments that have been carried out with grapes under the direction of the Station have not given any decided results. In the case of fruit trees the following experiments were made:

An average apple tree was selected by Mr. I. J. Blackwell, of Titusville, N. J., on May 4th, and kept wet with a force-pump for the six days covering the period of blooming. As a result, the flowers failed to set fruit, except in a few instances upon the upper branches. The weather was fair for the whole time and the surrounding trees of the same sort which were dry, set full with fruit.

While it is not necessary to give the tri-daily records of thermometer and other meteorological observations made by Mr. Blackwell, it is due him to say that one workman was employed for the whole time in keeping the tree sprayed, as the weather was clear and the atmosphere a drying one.

It would have been interesting to have studied the behavior of the pollen of the sprayed blossoms, but from a knowledge of apple pollen under similar circumstances, it is reasonable to conclude that it germinated wherever it lodged, and probably mostly within or upon the surface of the anthers that bore it. Many kinds of pollen germinate quickly upon being wet with rain-water.

EXPERIMENTS FOR THE YEAR UPON CRANBERRY DISEASES.

The Gall Fungus.

A large portion of Bulletin 64 (December, 1888) was taken up with a consideration of a new and peculiar disease of the cranberry that is limited practically to one bog—the Marian Furnace, located near Brown's Mills. It was found that this trouble was due to a fungus (*Synchytrium vaccinii*, Th.) that produced minute galls upon all parts

of the cranberry plant and rendered it incapable of producing a crop. It was also determined that the parasite was one that propagated in the spring and the contagion was carried in the water during the floods of April. The very contagious nature by means of water, if not otherwise, was demonstrated, and as the infested bog was located in the midst of a large cranberry-growing region, it was natural that many besides the owner should be deeply interested.

The writer was invited to address the American Cranberry Growers' Association at the annual meeting for 1889, and several members became so much interested that resolutions were passed, and the outcome was an act of the State Legislature, somewhat general in its nature, which is given below:

"An Act to prevent the spread of fungous diseases of plants.

"WHEREAS, The officers of the State Agricultural Experiment Station have discovered a certain new fungous growth that threatens serious injury to important agricultural interests of the State; therefore,

"1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey*, That when the officers of the State Agricultural Experiment Station shall discover any new fungous growth which is doing injury to plants or vines, and while the same is confined to limited areas, they are hereby authorized and empowered to enter upon any lands bearing vines or plants so affected, and destroy the same by fire or otherwise, as they shall deem best.

"2. *And be it enacted*, That any damage to private property resulting from the operation of destroying the said fungous growth, by the officers of the State, shall be certified to by them, and the amount of damage paid to the owners thereof, from the same fund and in the same manner as is paid to owners of diseased animals killed by order of the State Board of Health.

"3. *And be it enacted*, That expenditures under this act shall not exceed one thousand dollars in any one year.

"4. *And be it enacted*, That this act shall take effect immediately.

"Approved May 23d, 1890."

Two methods of treatment of the bog were suggested at the outset, namely, to withhold the water from the bog during winter and spring, if it was possible, and determine how this might affect the disease; or, secondly, at the proper season, burn over the whole attacked area and let the bog start up afresh from the ashes. It has seemed best to try the first method, and during the last winter (1889-90) the

water was kept off. This has had a good effect, and now the bog is looking much more healthful than for years before. In some of its parts it has been impossible to keep the bog dry, and in those portions the gall fungus is still present in great abundance, and it may be wise to attempt some other plan for eradication of the trouble from these parts; for until cleansed, they will be constant propagation-beds for the fungus, from which it cannot but spread with the passing water.

The area of the infested plants has not probably enlarged since the bogs were first examined, although last spring the fungus was reported by Mr. Pittman, the overseer of the bogs, four miles above the point where first seen and where doing the most damage. As this last point is upon the same stream, it may be the original locality from which the plants below, taking the impregnated water, became first infested. Should it be announced upon a new stream that feeds a large area devoted to healthy bogs, there would be cause for alarm among the cranberry-growers, and heroic methods would then need to be taken to stamp out the trouble. As it is, there is no bog fed by the waters that flow through the gall-infested area, and it is hoped that the trouble may be kept within its present limits and reduced to a minimum by the winter dry method now in use. This plan seems to satisfy those who are most interested.

The Cranberry Scald.

During 1889 an investigation of the cranberry scald was made, the result of which appeared in Bulletin No. 64, published December 31st of that year. It was then shown, with the aid of several illustrations, that the "scald" is due primarily to a fungus that is uniformly present in all scalded berries and also infests the leaves, vines and roots of affected plants.

The desire was expressed that experiments be carried out upon some of the bogs most badly infested, with a view of finding some remedy for the trouble that has caused a great loss to the cranberry crop in New Jersey for many years. During the past season tests have been made upon a number of bogs in various parts of the State, and an outline of this work, with the results of the same, is given below.

On May 23d, upon the badly-scalded bog of Charles G. Rockwood,

near Hammonton, the following substances, namely, bluestone, or blue vitriol (sulphate of copper), green vitriol (sulphate of iron) and flowers of sulphur, were applied, each upon four plots of a square rod each and not adjoining one another. The respective amounts of the bluestone were ten (10), five (5), three and a half (3½) and one and a half (1½) pounds. Double these amounts of the other two substances were applied to the sets of four square areas, namely, of green vitriol, twenty (20), ten (10), seven (7) and three (3) pounds respectively, and the same amounts of the flowers of sulphur to the third set of four plots.

The long distance of this bog from the Station and pressure of other work prevented my watching the experiments from month to month, but occasional reports were received from Mr. E. Van Hise, overseer of the bogs, and from his last letter the following short statement is quoted: "The experimental plots have all rotted and the vines are nearly all dead." At the time of the application of these remedies it was evident that the treatment was heroic, and one of the points was to determine the effect of such heavy doses upon the vines as well as the scald.

During the same day, applications of a different set of remedies were made upon the badly-scalded portions of a bog, also near Hammonton, and owned by Prof. A. J. Rider, Secretary of the American Cranberry Growers' Association. The plots were larger than those of the Rockwood bog, several miles away, namely, four square rods each, and in sets of four, staked out upon the bog. In this series, the substances were applied in pairs, with one exception, as shown by the following table:

Set.		Plot 1.	Plot 2.	Plot 3.	Plot 4.
I.	Flowers of sulphur	10 lbs.	5 lbs.	3 lbs.	2 lbs.
	Lime	10 "	5 "	3 "	2 "
II.	Flowers of sulphur	10 "	5 "	3 "	2 "
	Sulphate of copper	10 "	5 "	3 "	2 "
III.	Sulphate of copper	10 "	5 "	3 "	2 "
	Lime	10 "	5 "	3 "	2 "
IV.	Carbonate of lime	40 "	20 "	12 "	8 "

The results for the present season upon these plots are not at all pronounced, and do not warrant the conviction that any of the above-named substances will prove a cure for the scald. It is true, however, that the vines were not harmed by any of the applications,

some of which were made in excess of what it was supposed the cranberry vines would bear. This was done to hasten, if possible, the conclusion as to the most desirable amount of the remedy to use, provided one should be found. It is also due the experiment to say that there was a manifest decrease of the scald upon the several plots where the medium quantities (plot 2) of the substances were used. This was also true of the same number of plot when carbonate of lime was employed. The best plot, and quite easily observed as such, was the one that had received the bluestone and sulphur, five pounds each.

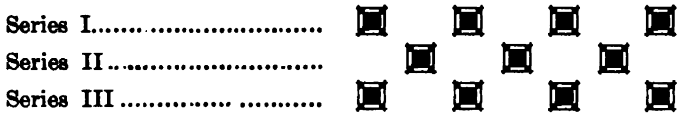
It should be borne in mind that the present year was an unusually favorable one for the development of the scald, and upon many large bogs the crop was for that reason almost an entire failure, and, therefore, it is possible that in an ordinary season the results might have been more favorable. From the nature of the scald, and that the fungus is deeply seated, it may be true that more than one season is required for the full effect of any remedy to be obtained. It is likely that these "squares" without any further treatment may show better results next season than they did this. At any rate, the design is to keep them under observation and close the tests with them when no further results can be obtained.

Mr. Ezra Stokes, of Berlin, kindly made similar tests, and reports no perceptible effect, and the vines were injured in one or two cases. In like manner, Mr. M. M. Chew, of Williamstown, experimented with various substances, and the following are his conclusions: "The lime did not make any difference, while the sulphur plots held their berries longer than usual, but they finally rotted. The bluestone did better than either (lime or sulphur), as some of the berries held on until ripe." Mr. Chew is sufficiently impressed with the virtues of bluestone to continue with it, and proposes to apply it as soon as the water is off in the spring.

Mr. Chas. S. Braddock, of Haddonfield, made several tests, as follows: Two pounds of sulphate of copper to the square rod; and while it did not affect the vines, no checking of the scald was noticed. Flowers of sulphur, two pounds to the square rod, improved the plot considerably, but "did not save all." Air-slaked lime did no good, and kainit, ten pounds to the rod, helped the vines, but the berries scalded worse than elsewhere. Mr. Braddock was much disappointed in the bluestone, as he had "used it upon his grape vines for the rot with great success."

The most extensive experiments were those upon the "Buckelew Bog," near Jamesburg, and everything was carried out under the writer's supervision.

There were ten sets of four plots each, that is, forty twenty-five-foot-square areas staked out. The relation of the plots to each other may well be represented as follows:



Five of these sets received a single application of a solid substance to be tested, as follows:

	Plot 1.	Plot 2.	Plot 3.	Plot 4.
I. Flowers of sulphur	10 lbs.	5 lbs.	3½ lbs.	1½ lbs.
II. Sulphate of copper	"	"	"	"
III. Air-slaked lime	"	"	"	"
IV. Common salt	"	"	"	"
V. Carbonate of lime	"	"	"	"
VI. Mod. eau celeste.* Sprayed equally over the four plots.				
VII. Sodium hyposulphate †	10 lbs.	5 lbs.	3½ lbs.	"
VIII. Sulphate of potash †	"	"	"	"
IX. Am. carbonate of copper ‡	"	"	"	"
X. Bordeaux mixture §	"	"	"	"

The liquids were applied as per table twice during the season. A careful examination of all the plots was made during August; the plants were all uninjured and no differences could be seen in the scald, which was already bad over the whole experimental portion of the bog.

It is proper to add to this report upon the cranberry scald, a brief statement of the results obtained by Mr. J. P. Goldsmith. For eight years he had had a bog upon which he experimented with sulphur, copperas, salt and plaster without success, and was unable to get a crop of berries, when he observed that a portion of another bog that had been filled in with subsoil from a higher piece of ground produced sound fruit. A similar deposit was found near the scalded bog

* Sulphate of copper, 2 pounds; carbonate of soda, 1½ pound; ammonia, 1 pint, diluted to six gallons.

† A half pound.

‡ Three ounces to one quart of ammonia.

§ Three pounds sulphate of copper with lime.

above mentioned, and with a scow, while the bog was flooded, the earth was carried and spread a half-inch thick over a half acre of the bog. The next season, as a result, half of the berries were sound and larger than usual, while the rest of the bog produced no sound berries. Afterwards, other bogs, almost worthless at that time, were covered to a depth of one inch, and for eight years since the berries have been sound.

The general character of the treated bogs is "savanna ground," black sand, some portions with mud a foot deep. Mr. Goldsmith believes any heavy clay spread evenly an inch thick on the bog will check the scald. The small, fibrous roots of the cranberry plants fasten upon and fill this layer, much to their advantage. Mr. Goldsmith says that his soil contains iron, and he is inclined to attribute something of the good results to this fact.

With this valuable experiment before us, it is well to return to the bulletin referred to at the beginning of the subject. Some of the readers may remember that in working up the history of cranberry scald and the conditions under which it flourished, a circular of questions was sent by the Station to all prominent cranberry-growers in the United States. From the tabulated replies it was quickly seen that New Jersey suffered most of all, and upon Cape Cod, for example, there was only a small per cent. of the scald, and that in bogs upon wet, peaty soils, where water constantly stands close beneath the vines. It seems clear that the conditions favoring the scald are to be found in the bog, its soil, water, etc., and not the surrounding atmosphere. It therefore follows that while substances sprayed or sprinkled upon the vines may check the ravages of the scald fungus, the cure of the malady must be in a renovated bog. The favoring atmospheric conditions, moisture and sunshine, are largely beyond man's control, and this may be true of the structure of the bog in many cases, but much is to be done, if done at all, along this line of improved soil conditions for the plant. The past year's experience with various fungicides does not inspire one with a full measure of hope along that line. If the Cape Cod growers are not troubled with the scald, and their bog conditions differ from those of New Jersey, it is now time to see if those favoring conditions may not prevail here. In other words, it seems wise to strive to obtain the conditions that surround the cranberry bogs of Cape Cod. While it is the intention to continue the experimentation with fungicides, it

would be equally well for owners of scalded bogs to try the sanding of a small area, if it can be done without too great outlay. There is, doubtless, much to be learned in the direction of a better drainage of the bogs, to so control the water that there will be no stagnant pools, as they may be the breeding-places for the scald.

THE FUNGOUS DISEASES OF THE SWEET POTATO.

Bulletin No. 76, upon the above subject, covering thirty-two pages and containing nineteen engravings, was issued from the Station, November 26th, 1890, and therefore is already in the hands of the farmers of the State. In that publication the following kinds of fungous trouble were considered, as mentioned in the concluding paragraphs:

SOFT ROT is caused by a mould that grows with great rapidity in the roots, and is usually most destructive to the sweet potatoes shortly after digging-time, while the roots are passing through the condition known as "sweating." The chief and effective preventive is at this time to keep the pototoes in a well-ventilated, dry room, maintained at the temperature of about seventy degrees, by means of artificial heat. Watch for and remove any decaying roots, as the fungus quickly passes from one potato to another, especially if bruised, cut or broken. This last suggests a further precaution of handling and marring the roots as little as possible.

BLACK ROT is caused by a mould that may enter the sprout from the mother root in the hot-bed and thus transmit the trouble to the potatoes of the next generation. It is also possible for the germs to remain for a considerable time in the soil and the rot to enter the roots directly therefrom. When once in the potato, it spreads through it, embittering and blackening the tissue until the whole root is worthless. The greatest precautions should be taken that only healthy roots are used in the hot-bed, and that all sprouts showing any signs of blackening of stem or young leaves be discarded. Field experiments in the future may lead to a direct remedy that may be applied to the plants or the soil, or both.

SOIL ROT is due to the invasion of a fungous growth that attacks the roots through their small lateral fibrils, usually when quite young,

and not being able to spread throughout the whole root, the further development of the infested potato may cause a partial obliteration of the disease. Plants badly attacked are not able to produce vigorous vines, and the roots, while often numerous, are mostly small and unmarketable. The fungus produces vast numbers of spores in the diseased tissue, and this becoming dry and powdery, the germs are largely left in the soil, where they probably retain their vitality for a long time, and serve to inoculate the roots of the first sweet potato plants that are set upon the infested soil. The use of healthy sprouts does not insure the crop from the fungus, and therefore remedy must be sought in ridding the soil of the germs, or preventing them from entering the young roots. The growing of other crops upon an infested soil for a term of years, while at a present comparative loss, is one of the most practicable methods of clearing the land. It is possible that the fungus feeds upon other than the sweet potato—a condition of things suspected from an examination of the roots of several weeds growing among the potatoes. Further field experiments need to be made before definite results as to application of remedies to the soil can be recommended.

STEM ROT. Upon this the investigations were begun too late to obtain the first stages of the disease. Several kinds of fungous growths have been met with, one or more of which may have been the cause. The young roots begin to decay near the top, the rot descending usually for only an inch or so, during which time new sprouts grow from below, but to no purpose.

WHITE ROT is associated with a blue mould, that beginning at the base of fine hairs, produces small, but slowly deepening and broadening pits, until the whole root may be changed into a dry, chalky, worthless substance. As yet, this form of rot is not common.

DRY ROT is another decay of the "sweets," of fungous origin; in this case not changing the exterior color, but transforming the substance into a dry, yellowish mass, with pimples upon the surface, in which the spores of the parasite are produced in great numbers. Fortunately this trouble is as yet not serious.

SCURF is a well-known superficial appearance of the potato due to a dark mould that grows in the surface-cells of the root, and after-

wards sends up dark spore-bearing stalks. While reducing the market value of the potato, the mould does not cause a destruction of the root, and therefore is not an occasion for any alarm.

LEAF BLIGHT is the name of a trouble due to a fungus that confines its work to the leaves, where it produces dead spots in the foliage and thereby weakens the plants to an extent proportional to the amount of spotting.

WHITE MOULD is more troublesome in New Jersey than the leaf blight, as it ruins the older leaves, which turn brown and die. It however, in contrast with soil, black and soft rots, is a comparatively harmless enemy. The first two of the last named must be the ones against the ravages of which the State and the Station should work systematically in the field.

FIELD WORK OF THE SEASON.

The field experiments with sweet potatoes in search for a remedy for the soil and black rots were carried out by several growers in the State. The method pursued was to apply a substance to a row ten rods long, leaving rows untreated between those receiving the remedy. The following were the substances employed: Flowers of sulphur, sulphate of copper (bluestone), air-slaked lime, gas lime, common salt and carbonate of lime. These materials were applied in four strengths, as follows: To the first treated row of ten rods, five (5) pounds; second, two and a half ($2\frac{1}{2}$); third, one (1), and fourth, one-half ($\frac{1}{2}$) pound. These rows, as before stated, being separated by one or more untreated rows.

Mr. J. F. Jenison, of Hammonton, used only the lime, and he reports that no effect was observed. He believes that for the black rot the most important thing is to use healthy roots in the hot-bed from which to get the sprouts.

Mr. Jos. W. Gill, of Swedesboro, tested the flowers of sulphur, sulphate of copper, lime, common salt and wood ashes, but there was no difference between the rows treated and untreated, as all failed from the soil rot.

Mr. E. G. Brick, of Penn's Grove, for black rot, treated four rows with twenty pounds of carbonate of lime, a second four was with ten pounds, a third set with twenty pounds of the lime and twenty of

potash, a fourth with ten pounds of lime and ten of potash. Upon ten-rod rows he also applied two and a half, and one pound each of sulphur, bluestone and air-slaked lime separately. There was so little black rot in the whole field that it was not possible to determine that the ingredients used were of any use.

Mr. Samuel Wood, of Haddonfield, made a full test of carbonate of lime in four sets of rows and with four different amounts, and reports that there was no rot anywhere in the field, and therefore no conclusions can be drawn from his results.

The most extensive experiments were made by Mr. Job S. Haines, of Mickleton, Gloucester county, with the assistance and under the additional supervision of Charles Heritage, Benjamin Heritage and William Ford, of the same place, in compliance with a suggestion of the State Botanist, and by request of the Gloucester County Board of Agriculture.

The following is Mr. Haines' report:

"The plot experimented upon was part of a tract which had been affected with this disease during the past five or six years. Size of said plot, five rods in length and four rods in width, marked out both ways two feet and nine inches apart, making twenty-four rows with thirty-four hills in each row as thus spaced.

"Four different brands of phosphate, ground salt, air-slaked stone lime, gas lime and wood ashes were applied broadcast on measured strips, the shorter way, with intermediate strips without such application. Twelve rows of said plot the longer way were treated with an application of flowers of sulphur spread in the furrows as follows:

Rows 1 and 2, 5 pounds,	or at the	rate of	425	pounds	per acre.
Row 3, not treated.					
Rows 4 and 5, 2½ pounds,	"	"	" 212½	"	"
Row 6, not treated.					
Rows 7 and 8, 1 pound,	"	"	" 85	"	"
Row 9, not treated.					
Rows 10 and 11, ½ pound,	"	"	" 42½	"	"
Row 12, not treated.					

"The remaining twelve rows were treated with sulphate of copper, in the same proportions, namely:

Rows 1 and 2, 5 pounds,	or at the	rate of	425	pounds	per acre.
Row 3, not treated.					
Rows 4 and 5, 2½ pounds,	"	"	" 212½	"	"
Row 6, not treated.					
Rows 7 and 8, 1 pound,	"	"	" 85	"	"
Row 9, not treated.					
Rows 10 and 11, ½ pound,	"	"	" 42½	"	"
Row 12, not treated.					

"Well-decomposed stable manure was used on the whole plot, in medium quantity only, and placed in the hills as marked out, and also between the hills the longer way, making the spaces between the plants 16½ inches.

"Hills were made with the hoe, thus partially mixing the various ingredients with the soil. The plants were immediately set in the hills, 1,608 in number, and well watered, on May 30th, 1890. The weather was warm and dry, and continued so for some time. The plants started favorably and made nearly the usual growth for about one month, after which signs of the disease began to appear, both upon the top and root of the plants, but subsequently they in general regained their apparent health.

"On October 30th, being five months from the date of planting (vines still remaining green), the crop was gathered and carefully weighed. The results were as follows: Yield upon that portion of the plot on which flowers of sulphur was used, namely:

Rows 1 and 2, 5 pounds, at a cost of $10.62 per acre....	yielded	8,422	pounds per acre.
Row 3, not treated....................	"	6,500	" "
Rows 4 and 5, 2½ pounds, at a cost of $5.31 per acre....	"	5,208	" "
Row 6, not treated....................	"	4,774	" "
Rows 7 and 8, 1 pound, at a cost of $2.12 per acre.......	"	4,087	" "
Row 9, not treated....................	"	3,642	" "
Rows 10 and 11, ½ pound, at a cost of $1.06 per acre...	"	2,986	" "
Row 12, not treated....................	"	4,849	" "

"Where sulphate of copper was used:

Rows 1 and 2, 5 pounds, at a cost of $29.75 per acre....	yielded	3,600	pounds per acre.
Row 3, not treated....................	"	3,494	" "
Rows 4 and 5, 2½ pounds, at a cost of $14.87½ per acre,	"	4,553	" "
Row 6, not treated....................	"	6,670	" "
Rows 7 and 8, 1 pound, at a cost of $5.95 per acre......	"	3,918	" "
Row 9, not treated....................	"	3,536	" "
Rows 10 and 11, ½ pound, at a cost of $2.97 per acre....	"	4,530	" "
Row 12, not treated....................	"	4,335	" "

"The amount and proportions of flowers of sulphur and sulphate of copper used were in accordance with the plan suggested by the State Botanist. The average product per acre, as taken from the above, was as follows:

Where no sulphate of copper was used..................................	4,700	pounds per acre.
Total average where sulphur in all the four proportions was used..................................	5,175	" "
" " " sulphate of copper in all the four proportions was used..........................	5,175	" "
Increase of crop where sulphur, 425 pounds per acre, was used................	30	per cent.
Decrease of crop where sulphate of copper, 425 pounds per acre, was used...	23	"

"The yield on the strips of said plot where the phosphates, lime, salt and ashes were applied, was as follows:

2 rows not treated	yielded	5,495	pounds	per acre.
2 rows treated with phosphate (Wm. Clark), 600 pounds, at a cost of $11.10 per acre	"	7,395	"	"
2 rows treated with phosphate (Swift Sure), 900 pounds, at a cost of $14.85 per acre	"	9,585	"	"
2 rows not treated	"	5,250	"	"
4 rows treated with wood ashes, 1,000 pounds, at a cost of $7 per acre	"	3,060	"	"
4 rows treated with stone lime, 1,000 pounds, at a cost of $1.75 per acre	"	4,155	"	"
4 rows treated with gas lime, 1,000 pounds, at a cost of 85 cents per acre	"	4,297	"	"
6 rows treated with ground salt, 300 pounds, at a cost of $1.50 per acre	"	4,750	"	"
2 rows not treated	"	3,120	"	"
3 rows treated with phosphate, 667 pounds, at a cost of $13.33 per acre	"	5,600	"	"
3 rows treated with phosphate (Jno. I. Smith), 667 pounds, at a cost of $13.33 per acre	"	5,532	"	"

"The yield where nothing was applied, on the intermediate strips the shorter way of the plot, equaled 4,590 pounds per acre. From the above it will appear that all the phosphates used, and also the ground salt, produced an increase of the crop above the average result where no application of the kind was made.

"Upon two square rods of land adjoining the above, a very heavy dressing of well-decomposed stable manure was applied broadcast, and a moderate quantity in the drills also. The plants started equally well with the others and maintained their vigor the entire season, without any visible signs of the disease upon that portion of them above ground, yet the roots indicated its presence to a great extent; and although we have no exact record of the yield, yet it was very heavy in comparison with the best portion of the other plot."

It is evident that the results of the year's experiments do not warrant the drawing of any definite conclusions. As yet there is no specific discovered for the soil or black rot of the sweet potato. The work must be carried on for a longer time.

FUTURE FIELD WORK.

It is certain, from the nature of the rots, that a knowledge of the possible remedies and most effective preventives can only be obtained by thorough field experimentation in the localities where the particular troubles are prevalent, and therefore cannot be prosecuted at the Station. It is consequently hoped that several growers of sweet potatoes will be willing to enter into correspondence with the Station Botanist, with a view of assisting in the experimental work of testing

remedies. For this purpose an early response is desirable, that the work may be fully outlined and arranged for before the time comes for active field work in the early spring.

Besides those persons whose names appear in the body of this report upon the sweet potato disease, it is my pleasure to thank especially Mr. Jesse S. Brown, of Swedesboro, who kindly welcomed me to his home, where a week was spent in the microscopic study of the potato rots that were abundant in his vicinity, and for many other courtesies shown me in obtaining diseased specimens. To Mr. Benjamin Heritage, of Mickleton, special thanks are due for his prompt and thorough work in collecting and sending specimens to the Station whenever they were desired for carrying on the investigations. Many others have aided me materially in the work, and while their names are not mentioned here, it is nevertheless true that all their favors have been appreciated.

FUNGOUS DISEASES OF VARIOUS CROPS.

POTATOES.

This has been a year of troubles with the potato. In many parts of the State the crop has been large and profitable; in others, abundant, but decays of various sorts have been destructive. In Salem and Cumberland counties, for example, the growers, perhaps, have suffered most. Many diseased specimens have been sent to the Station from South Jersey, and the complaints were so great that a visit was made in early October to some of the worst places. In some fields the tubers had been dug, placed in heaps and there remained a worthless, rotten mass. Other farmers were plowing the ground for wheat, paying no attention to the large crop of decayed potatoes in the soil. In short, the entire crop rotted, and that means a great deal in a region where this crop is a leading one—some farmers growing not less than fifteen thousand bushels.

The cause of this wholesale decay was in part, at least, due to the fungus *Phytophthora infestans*, De By. This is a sort of mildew, the habits of which have been so widely written about that further treatment is not needed here. In 1888, August 4th, a bulletin (G) was issued upon it, and the treatment of the crop suspected of being attacked, and in the last report of the State Board of Agriculture a full-page plate with description was given of the pest by the writer.

As illustrating the rapidity with which this fungus grows, it may be said that from fresh slices of diseased potatoes sent from Salem county, the mildew grew to full perfection of its spores in the short space of four hours. The potato *Phytophthora* is one of the most rapidly growing of all fungi injurious to cultivated crops, and this helps to explain the seeming mystery connected with the quick passage of this trouble through a field or larger section of the country.

While the fungus is the cause, it, like all other things, is a creature of circumstances. It is specially fond of wet weather, and therefore its control is possibly not entirely within reach of the grower of the crop. Experiments with the Bordeaux mixture by various persons in the State, have shown that something can be done to check the malady, and when the process is fully worked out in all its details, it is very likely that much more will be accomplished toward mitigating the evil. It is also possible that a more effective fungicide may be found than any thus far used, and by applying it at the same time with the insecticide for the "bugs" there will be only a minimum of expense. But in order for any substance sprayed upon the vines to be effective, the application should be made early, even before the fungus is expected, and these times accord with those for spraying for the insects.

While the importance of using healthy seed from non-infected regions is doubted by many, it seems to me unwise to employ potatoes suspected of being affected. There is one important lesson that suggests itself in connection with the rot of the present season. The early crop, as a rule, was good, and in the market before the rot came. It was the late sorts, making their growth in autumn, that were struck and perished by the decay. Other things being the same, it is doubtless true that it is better to have the crop made late in the season, but if the attempt means failure, it certainly is wisdom to grow an earlier crop and get the tubers out of the soil before the wet weeks of autumn come. This is advocated in the face of the fact that it may interfere, in various ways, with the methodical arrangement of labor and other matters in the management of the farm.

It is certainly time that potato-growers carefully considered these questions, for it is always the one who saves his crop amid surrounding failures that commands the market. Bear in mind, therefore, that a late crop is a dangerous crop, and only grow it when the possible gains justify the risks.

BACTERIA. In connection with the widespread and destructive decay of potatoes of South Jersey, there was a second form of rot quite different from that caused by the *Phytophthora*. In this the potato developed well-formed ulcers, and slices of these quickly turned to almost a coal black, especially near the surface beneath the skin, and over all rapidly grew an almost velvety layer, consisting entirely of masses of bacteria.

Dr. Burrell, of the Illinois Experiment Station, a well-known authority upon bacterial diseases of plants, had observed a similar development, and now has this form of potato rot under investigation. At the time of writing it is impossible to state how much of the destruction of the last potato crop is due to the work of bacteria. If these minute germs are to be credited with a large share of it, the question of remedies is a more difficult one to answer than ever before. It only emphasizes the importance of giving the best conditions for a healthy life.

In this connection it may be said that specimens of rotten potatoes were obtained direct from Ireland, where during the past season there has been a great amount of the rot. Upon subjecting the tubers to cultural treatment and microscopic examination, it was found that while several moulds developed as secondary elements in the decay, the primary cause was *Phytophthora infestans*, namely, the old enemy that brought on the famine that devastated and depopulated the sad island many years ago.

SCAB. Many specimens of scab have been sent in for consideration, and as this subject has been thoroughly studied by Dr. Thaxter, of the Connecticut Station, during the past year, it need only be said that it, or at least one form of it, for there seems to be several, is due to a minute organism of the fungus group which can be transferred from diseased to healthy tubers with much certainty. It is also believed that the fungus breeds in decaying substances in the soil, and that rotting manure may be the worst thing for a potato field if the germs of the scab are then present. It would be well for farmers who have been afflicted with the scab, to test alternate belts of manure of various sorts with some of the standard commercial fertilizers. This is the only satisfactory way of getting a practical answer to the question of what are the least favoring circumstances for the development of the scab.

A second form of scab has been fully investigated by Prof. H. L.

Bolley, of the North Dakota Experiment Station, who found a bacterial germ associated with the trouble. As this scab is different from the one worked out by Dr. Thaxter, it follows that there are at least two kinds of potato disease passing under the common name of scab.

CABBAGE.

The worst fungus enemy to the cabbage in the State has been the so-called club-root (*Plasmodophora Brassicæ*, Wor.), as in many gardens it has entirely ruined the crop. The fungus is of a very low order, consisting of minute bodies that propagate rapidly in the cells of the young roots and cause them to become a mass of irregular, misshapen warts and knots. Usually the older portions soon decay and new roots being sent out from above, in turn become knotty and decayed, giving off a most offensive odor. Sometimes the club-root attacks the young plants while they are still in the hot-bed or propagating-bed, as was reported by Mr. Daniel Jones, of Freehold. In such cases it is not only wise to destroy all the plants but also either cease growing the crop largely, for a few years, or obtain plants from some person who is free from the trouble. It is to be borne in mind that this fungus works below ground and the vast multitudes of germs produced quickly inoculate the soil, and therefore the precaution of abandoning the crop upon infested land is exceedingly important. This is all the more imperative as the disease is out of the reach of the immediate action of fungicides. The fact is well known that when this plasmodophora once gets into the soil it remains for some time.

In this connection it should be said that the same fungus preys upon the roots of the turnip, causing them to become quite distorted, decayed and worthless. The complaints, however, are not so frequent with turnip as the cabbage, but that the club-root is common to both should be understood in planning a rotation of crops. For example, if a plot of ground devoted to cabbage proves a failure on account of the insidious plasmodophora, it is evident that turnips should not be attempted there the next season.

Again, the radish is attacked by what seems to be the same fungus. While no mention is found of this fact, the general one is often stated in the books, that the species infests several kinds of cruciferous plants. In the radish there is more darkening of the tissue of

the root than is seen with the turnip and cabbage, and upon the pure-white varieties of radish this discoloration, if nothing more, would render the roots worthless for market. That which has been said as to rotation of crops or abandonment of cruciferous plants applies with full force to radish culture. One extensive grower of this crop has found his radishes worse from year to year, and the present season they were so nearly worthless that he will grow other things in their place for a few years. It is likely that the land may have become first "seeded" with the germs of the fungus from a crop of cabbage, as that seems to be the plant in which the trouble is most easily propagated. There are several weeds that belong to the mustard family, and it is to be expected that these, some or all, are also similarly affected, and if so, they, if left to grow, become a ready means of preserving a supply of the malady close at hand. For this suspicion and other sufficient reasons, it is evident that weeds of the mustard group, including charlock, hedge mustard, shepherd's purse, pepper-grass and the mustards proper, should never find a breathing-place in truck gardens, if allowed to flourish anywhere. In dealing with the diseases of roots of plants it is essential that the soil be kept as clean as possible of all germs that otherwise might enter directly from the surrounding ground.

To return to the cabbage, only two other fungi need be mentioned as among those that materially affected the crop. A mildew (*Peronospora parasitica*, De By.) was found upon the outer leaves quite generally in one large field, causing the foliage to wilt and die. This seems to be the first time that this observation has been recorded for America. It may be said, in passing, that the same mildew was found in May and throughout the season upon the foliage of the common rocket (*Hesperis matronalis*, L.), a showy, ornamental member of the cabbage family. Several other species of the family were also attacked by the same mildew, which only emphasizes the fact that plants of near kin may all be subject to the inroads of a single parasite. The same mildew was also occasionally met with upon the radish, especially the maturing pods. The last fungus of the cabbage to be mentioned is a black mould (*Macrosporium Brassicæ*, Berk.), that by blackening and killing the leaves often does much damage to the crop.

RADISH.

In addition to the fungi already mentioned as preying upon the radish, there was a white mould (*Cystopus candidus* (Pers.), Lev.), that proved very destructive to the seed-growers of South Jersey. This fungus has a remarkable way of attacking the flowers, flower-stalks and half-grown pods, and therefore deals its blow at a point most fatal to the seed crop. As the affected parts are quite conspicuous, it would not be a great task for the seed-grower to remove and burn them. At any rate, all the infested plants in a field should be burned so soon as the crop of seed has been removed. It cannot be restated too frequently that the burn-heap, well used, is one of the best allies of the crop-grower. There is a cleaning up of the rubbish at the close of each season that is wholesome, and at the same time detracts nothing from the appearance of the place. There should be the fewest possible breeding-places for the various enemies of crops.

TURNIP.

There is only one other trouble among the mustard-like plants that space will permit mentioning here, namely, the root rot of the turnip, and as other similar root crops have been affected in the same way, the whole group will be treated at the same time. Last year there were many complaints of the wholesale decay of the turnip, both in the field before harvesting and in the root-cellar during the winter. An inspection of the turnips at the time showed that there was a fine filamentous fungus present in great abundance, which quickly covered the decaying turnip. Several of these mouldy roots were laid away in a dry place for further developments, and soon nodules of the fungus began to form, which finally turned of a black color, became hard, and were evidently of the sclerotial form so often assumed by many species of fungi. These bodies, after reposing for the summer, are now placed under conditions probably favorable for growth, and it is hoped that the full knowledge of the fungus in question may be forthcoming. Carrots at the same time were being lost by a rapid decay, many growers having hundreds of bushels rotting at one time. The rank growth seemed the same as that upon the turnips, and there was a similar development of the sclerotial form. The results of fur-

ther study upon this subject must needs be reported on at a later date, as it is one of the many unfinished problems that always attend the work of an experimental station.

SALSIFY.

It is to a second form of root rots to which the reader's attention is more particularly invited at this time. The observations along this line were opened by noting that the salsify, sometimes called vegetable oyster, was looking badly in many parts of the State as early as July. Instead of the plants having their usual green color attendant upon a healthy growth, the leaves exhibited an unsatisfactory mixture of brown and yellow, and were largely prostrate upon the ground. As the season advanced, the roots became a mass of rottenness, often long before the time for harvesting arrived. An examination of the roots in various stages of decay showed that rotting begins usually at the lower end of the main root, and quite rapidly works its way up to the crown. The decay is slimy and very offensive, and there is but little left of the root structure excepting the scattered vessels and woody fibers, which, on account of their hard walls, resist the corroding action of the agent of decay. No threads of any fungus were to be found in the recently disorganized tissue, but thin sections of those portions undergoing decay showed invariably that the cells were filled with bacteria. The first effect of the germs is to dissolve the substance between the cells, setting them free from each other. After this the bacteria penetrate the cells, swarm in their contents and literally fill the cavity with a moving mass of microscopic particles. Inoculations of the bacteria were made with ease in the healthy tissue of other roots, and the infection spread from each point with remarkable rapidity.

While in South Jersey, during September, my attention was called to a disgusting decay of the turnips growing in the field. The leaves of the affected plant would be dead or nearly so, and the root so thoroughly decayed as to leave little more than the rind as a shell. In this case no filamentous fungus could be assigned as the cause, but instead there were multitudes of bacteria, especially in the parts that were passing through the first stages of decay. Inoculations of the bacteria were made in healthy tissue, and the decay quickly followed in each case.

CARROT.

About the same time a quantity of carrots was sent to the Station, in which the same role of bacterial destruction was traced by microscopic study and inoculations. A similar trouble was found among autumn onions set for seed. Perhaps one in fifty of the plants was pale yellow, and the bulb more or less decayed. While nematodes were found in these, the assurance comes upon good authority that they were not the primary cause of the decay. My other engagements were such that it was impossible to carry out a strictly bacterial investigation of these decays, but as far as the inspection has gone, it seems clear that in these rapid, offensive and particularly destructive rots of the salsify, turnip, carrot and onion we have a bacterial enemy, and therefore one that cannot be subdued with ease, but on the other hand is exceedingly contagious in its nature. In other words, the remedy is not easy to suggest or apply. As the seat of the trouble is below ground, its presence is not easily detected until the ruin is begun. It is not likely that a fungicide can be sprayed with saving effect upon the plant. It is likely that large quantities of decaying manure in the soil may furnish the fitting conditions for the rapid development of the bacteria, and therefore, possibly, the use of commercial fertilizers may mitigate the trouble. By the paling of the plants, particularly the salsify and onion, the enemy may be detected, when it would be wise to remove the decaying bulbs as they may appear from week to week, and this point in the care of the crop should not be neglected.

ONIONS.

During the winter the onion bulbs decayed badly in market, due to a botrytis, probably *B. parasitica*, Car., which sends its filaments all through the scales and clothes the affected parts with an ashy-gray covering. Usually in connection with this mould there form dark, almost black, indurated masses of filaments that are the sclerotial formations of the infesting fungus. In a peck bought for home use, there was a quarter of the bulbs that had decayed places in them, often beneath the outer scales, and therefore the sclerotial masses were out of sight. These have been placed under conditions for development, but as yet the further history of the fungus has not been made out.

A more serious trouble of the onion, and perhaps the most to be dreaded, has made its appearance in the State, namely, the onion smut (*Urocystis cepulæ*, Fr.) This has been exceedingly disastrous to the onion industry in some localities in Connecticut, as Wethersfield, Southport and Green's Farms, where the crop has been abandoned over large areas because of the prevalence of the smut. Complaint was made by a large truck and seed-grower in Cumberland county in July, that his onion sets, of which he had several acres, were failing in a mysterious way, and the crop prospects growing less day by day. Upòn making a visit to the affected grounds, it was at once seen that the obscure but fatal trouble was nothing less than the smut. The fungus reaches the most vital point of the onion very quickly, and therefore before outward signs of its presence are manifest, the plant is past recovery and the black spores have been formed in the internal substance of the leaves and young bulb The smut is close to the ground, either in the soil or just above it, and as the diseased plant decays, the spores become mingled with the ground. These black, dust-like bodies, although microscopic, are capable of retaining their vitality for many years. In Connecticut, where this trouble has been serious for a long time, and is made a special subject of study by Dr. Thaxter, of the Experiment Station, it has been found that the spores will remain dormant for a dozen, and possibly in some cases, twenty years. It has also been determined that the smut makes its entrance into the seedling onion from the ground, and therefore a remedy for the trouble must be in large part a soil treatment—that is, apply the fungicide to the ground along with the seed in the drill.

From the extensive tests of a large number of substances in various combinations by the Connecticut Station, as outlined in the last annual report, it is said that flowers of sulphur is "the only one which merits consideration from a practical standpoint," and, "although the treatment with flowers of sulphur cannot now be measured, it is hoped that the experiments of another season may give results sufficiently good to warrant such recommendation."

There are certain precautions to be observed on all onion-smutted land. Burn all refuse at every weeding and after the harvesting of the crop. Exercise precaution in the use of implements, that the smut be not thereby transferred, in adhering earth, from infested areas to those previously free from the trouble. The best means of avoiding smut is to abandon old onion land that has become smutted, and

grow the crop only upon soil that is free from it. A direct remedy is expensive, and at best cannot be expected to be more than partial.

A third fungus has been abundant upon the sets as found in the market, and is known as the Onion Vermicularia (*Vermicularia circinans*, Berk.) This fungus is particularly conspicuous upon the white sorts, as it causes black blotches often surrounded by black rings. The value of the bulbs attacked is often greatly impaired, so that the loss to a single grower may be thousands of dollars. As this disease grows rapidly in the storage-room, it is important that the bulbs be harvested in a dry condition and stored in a cool place free from moisture. Sprinkling the onions with air-slaked lime at storing-time may check the spread of the fungus. It is not best to use the blighted onions for future crops.

The last fungous trouble to be noticed under onions, is a species of black mould (*Macrosporium*), that does considerable damage to the onions being grown for seed. At about the time the plants are in flower, spots, at first small and pale-colored, appear upon the stem a foot or so below the head of blossoms. This spot continues to enlarge and turns light brown and finally sometimes almost black. There may be two or more places of attack upon a single stalk, but at the worst the decay is so great that sufficient strength is not retained to support the upper portion of the stalk, and the head falls over and becomes worthless. In some fields fully fifteen per cent. of the stalks were found broken over at the time of visiting in midsummer, and for the whole season the loss was considerably more.

It is doubtful if any effective remedy can be applied directly to the crop, but it is certain that every stalk that becomes affected should be gathered at the time and destroyed, for the sake of keeping the enemy as much within bounds as possible.

SPINACH.

On July 26th, a sixteen-page bulletin (No. 70), with twenty-one engravings, was issued upon "Some Fungous Diseases of the Spinach," and as this has been widely circulated within the State, but little further needs to be said here upon this subject. It was shown that four species of fungi were met with, namely, (1) a mildew (*Peronospora effusa*, Rabenh.), (2) an anthracnose (*Colletotrichum spinaceæ*, Ell. & Hals.), (3) a leaf blight (*Phyllosticta chenopodii*, Sacc.) and

(4) a white smut (*Entyloma Ellisii*, Hals.), besides several kinds of black mould, the most common of which is *Cladosporium macrocarpum*, D. Two of the fungus enemies proved to be new, namely, the anthracnose and the white smut, the former being the most destructive of all. It was determined by laboratory experiments to be very contagious and rapid in its development; healthy foliage showing fully-developed disease patches within six days after inoculation. Since the issuing of the bulletin another fungus enemy has been found upon the spinach, and so destructive as to ruin the crops. For example, in the truck farm where discovered, the loss caused by it was estimated at not less than four hundred barrels. Instead of the ordinary rich, healthy green of the succulent foliage, the plants of the whole field presented a pale-yellow, sickly, dwarfed appearance, and while they were more than half the normal size, they were worthless for market. The trouble was due to the ravages of a leaf blight and a member of the genus *Cercospora*, to which belongs the celery rust (*Cercospora apii*, Fr.) The cercospora causing the leaf spot of the beet in some respects closely resembles the one upon the spinach. And as the two hosts are members of the same family, it was natural to expect that the two blights were caused by the same species of fungus. But as species go in this genus there are ample grounds for a distinction, and attempted inoculations and cultures confirm the latter view. On account of the exceedingly long, curved and tapering spores, the name of *Cercospora flagilliformis*, E. & Hals., has been given to this very destructive blight of the spinach.

EGG-PLANT.

The egg-plant has been seriously troubled with fungus enemies during the past year, and as a consequence the crop was light, and in some parts almost a failure. Reports came early in the season from various growers that the plants lacked vigor while still in the hot-bed, and in some cases many of them died before transplanting. An examination of these plants did not bring satisfactory results at that time, but later in the season, upon visiting a number of the growers, it was evident, especially in Gloucester county, that the trouble was due to an unusually severe attack of a leaf-spot fungus known as *Phyllosticta hortorum*, Speg. A microscopic examination of the diseased and developing leaves reveals the threads of the parasite within

the pale-yellow tissue. These threads congregate in patches, and produce brown or gray dead patches, over which small dark specks are finally developed, after which the leaf tissue becomes broken up. At the same time, should the plant be coming into bearing, the young fruit will exhibit soft, somewhat shrunken patches, over the surface of which pimples develop similar to those before mentioned as upon the leaf patches. Figure 4, *a*, shows a young fruit with three of the diseased patches, one of which is made up of three smaller ones that

Fig. 4.

have become confluent, while at *b* is seen an affected leaf with the diseased patches in various stages of their development. The spores produced by the fungus in the fruit rind and the leaf patch agree in size, shape, etc., and are shown at *c*. The spores germinate with ease after being immersed in water for a few hours, and complete inoculations can be made upon healthy fruit in thirty-six hours. It was demonstrated, beyond question, that the fungus of the leaf and the fruit is one and the same thing. At *d* and *e* are shown some further details of the structure of the spore-bearing bodies, and the manner in which the spores escape from the cavities in which they are borne. At *d* is shown a highly-magnified view of a portion of the surface of the diseased fruit, the pimples appearing like miniature mole-hills,

and from the top of each protrudes a coil, which is made up of a countless number of spores held together by a mucilage. Whenever the surface of the decayed fruit is moistened, the contents within swell, and a new mass of the spores is pushed out through the opening at the top, while at the same time the mass already outside is dissolved, and the spores become widely dispersed. The internal structure of the cavity and the manner of producing the spores, are shown at *e*.

While there has been thus far only time to study out the nature of this trouble, it seems clear, from the close relation, for example, that this fungus bears to the black rot of the grape, that remedies may be applied with reasonable hope of checking the disease. It is therefore recommended, first of all, that the treatment with the Bordeaux mixture or the ammonia carbonate of copper compound be begun early, while the plants are still in the hot-bed, and continued in the field so long as the blight is seen. This crop is particularly well adapted for spraying, and should there be any seriously injurious insects, the remedy for them can be mixed with the fungicide and both applied at the same time.

It should be borne in mind that the decayed fruit, when left in the field, become the propagating-places of the fungus, as each maturing pimple contains vast numbers of the spores. Therefore, it is a wise precaution to gather all such worthless fruit from the plants or the ground to where they may have fallen, and burn them. Still better, consign all badly-diseased plants, as a whole, to the burn-heap, and grow the next crop as far as convenient from the infested field.

A second form of fungus that helped materially to carry off the crop was an ashy mould (*Botrytis fascicularis* (Cd.), Sacc.), which flourished upon the fruit. With the purple sorts, the advent of this mould was made manifest by the change of color to a shade of tan over large blotches, followed by softening and the rapid development of a beautiful gray covering of delicate fungous threads containing multitudes of spores, while the fruit almost dropped into a rotten mass. It was an easy matter to propagate this mould from one fruit to another, and therefore, while not appearing upon the leaves, as in case of the blight above treated, the botrytis is certainly a contagious enemy to the producer of egg-plant fruit, and the merchant and consumer as well.

A third fungus of the egg-plant was occasionally met with alone

and in connection with one or both of those already mentioned. This is a genuine anthracnose, and is first observed by producing a decided pit in the surface of the fruit, upon which soon appear minute blotches that are tinged with pink. It does not seem to be recorded, and the name of *Glœosporium melongenœ*, E. & Hals., has been given it. Until more abundant than at present nothing need be feared from it, besides the spraying for the blight will doubtless prove an efficient check for this egg-plant anthracnose.

PEPPERS.

The growing of peppers for Eastern markets is a large industry in central and southern parts of the State, and owing to the complaints coming from those engaged in this industry, the fungous enemies of a

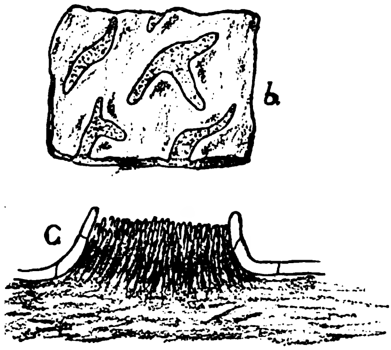


Fig. 5.

parasitic nature have been examined into so far as time would permit. Early in the season the fruit began to be attacked with an anthracnose, causing soft patches that exhibited rifts in the skin, through which the spores appeared in great abundance. This proved to be *Glœosporium piperitum*, E. & E., a species that Mr. Ellis first found in the Vineland markets the November before. This is so new and has proved so destructive to the pepper crop that an engraving is given of it in Figure 5. At *a* is shown a young pepper still green, upon which were three circular patches of the anthracnose, as may be seen indicated in the engraving. A small portion of one of the infested patches is shown at *b*, where the irregular rifts in the tough skin can be seen. A section through one of these cracks appears as

shown at *c*, the short threads of the fungus forming a dense mass with the spores borne upon the tips. The shape, relative size and manner of formation of these spores are shown at *d*, where the parts are highly magnified.

A second species of anthracnose belonging to a genus very closely related to the above, was found in the pepper field of Mr. Jesse S. Brown, near Swedesboro. This formed decayed patches also in the young and ripening fruit, but instead of the color remaining unchanged it turned to a decided black, the color being due to the multitudes of dark bristles that were interspersed with the colorless spore-bearing threads. In Figure 6, upon the left, is shown a pepper with

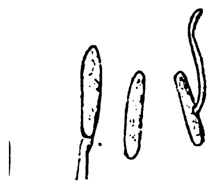


Fig. 6.

two affected patches, the larger and darker being the older. In the upper center of the engraving is shown a magnified portion of the dark diseased patch with the dark rosettes. A single cluster is shown below, still more highly magnified, and a thin section through the same indicated in the lower right-hand corner. The spores still more enlarged are seen just above. This fungus proved to be new, and on account of its abundance of dark bristles and almost charcoal appearance of the badly-infested parts, the name of *Colletotrichum nigrum*, E. & Hals., has been assigned to this second anthracnose of the pepper. The two engravings serve to indicate the constant differ-

ences that exist between the two species of anthracnose preying upon the same kind of fruit, and in fact may be associated in the same specimen.

As to remedy, there is but little doubt that the Bordeaux mixture or the carbonate of copper and ammonia compound will either or both meet the case. It is heped that those who have felt the loss most seriously will be pleased to make a thorough test of the proposed remedies, and they may feel assured that the Station Botanist will do all he can to assist in the trials, but it is one of those things that must be tested when there is good reason to expect that the malady will be forthcoming and anticipate its advent.

A third species of fungus was found upon the foliage, only, of the pepper, in several localities, and while some plants were evidently weakened by it, as a general thing the effect is not deleterious. In this the affected leaves become marked with small circular spots of an ashy color, over which are small black pits bearing multitudes of colorless spores. It is a member of the genus *Phyllosticta*, which contains a large number of the so-called leaf-spot fungi, some of which are very destructive. While apparently undescribed, its place will not be assigned until further study can be given it.

HORSERADISH.

Mr. W. T. Woerner, of Piscataway, among other kinds of truck, grows quantities of horseradish for market. During the present season he has complained that his crop has been almost ruined. The foliage lacked its usual vigor, turned yellowish, and after midsummer became filled with innumerable holes. Upon making a microscopic examination of the diseased plants it was found that the trouble was due to the unusual development of a leaf-spot fungus (*Septoria armoraceæ*, Sacc.) which literally riddled the leaves. While the fungous threads penetrated throughout all parts of the leaf, they congregate in spots for the production of spores, and in these places the tissue became lifeless, brittle, and soon broke away, leaving the holes.

A second form of fungus, namely, a white mould (*Ramularia armoraceæ*, Fl.), is frequently met with upon the horseradish, and sometimes does considerable damage to the leaves, but during the present season, while abundant, it has not equaled the leaf-spot fungus in its destructive work.

HOLLYHOCK.

The hollyhock is the victim of several very destructive fungi, three of which need mention here as particularly prevalent during the past year. Until last September the writer had not met with the rust of the hollyhock (*Puccinia malvacearum*, Mont.), but then it was found unusually abundant in the gardens near New Brunswick, where it had covered the leaves and petioles and ruined the plants. Since then specimens have been sent me for identification from North Carolina, where it is reported as being common and destructive. This pest, originally coming from Chili, has spread with great rapidity and fatality over Europe and now is gaining a foothold in this country. The *Gardeners' Chronicle* for August 23d, 1890, has an illustrated article upon this fungus, and outlines the treatment that has proved most advantageous for the English growers of the host. In the issue for September 20th, a new disease of the hollyhock is figured and described. In this, not yet observed in this country, the stems turn white, and when split open small black bodies are found that are the sclerotia of an invading fungus.

A disease that for the past two years has been particularly destructive in this State is the so-called hollyhock leaf spot (*Cercospora althæina*, Sacc.), which in its various forms flourishes upon the common mallow and the stout weed known as "velvet leaf." Last season it was almost impossible to find a healthy hollyhock plant. The lower leaves begin first to exhibit large circular brown patches, bounded in part by the veins, thus giving them an angular outline. Soon after the leaves fall, and by midsummer whole rows of the plants exhibited leafless stems. The disease invaded the green-house in winter and attacked the young seedlings in the propagating boxes to such an extent that to raise healthy plants seemed a hopeless task. Frequent and thorough applications of the mixture of carbonate of copper in ammonia proved, however, an effective remedy.

A third serious enemy of the hollyhock is comparatively new, but has, however, rendered it almost impossible to grow seedling plants in many of the large propagating-houses in this country. This enemy has been thoroughly studied by Miss Southworth, of the Division of Vegetable Pathology, at Washington, and described, with plates, in the last volume (6) of the Journal of Mycology (pages 45 to 50). This blight, *Colletotrichum malvarum* (B. & Casp.),

South., is amenable to treatment, and of all the fungicides thus far tested the Bordeaux mixture has proved the most successful. The foreman in the green-houses in Jersey City, where the tests were made, was satisfied that the results justified more extended spraying.

VIOLET.

One of the leading plants of the green-house and ornamental grounds most needing its fungous enemies investigated is the violet (*Viola odorata*). There are fully fifteen parasitic fungi recorded as making their particular, if not their only, home upon this species of violet, any one of which is sufficient to cause distress. The labor of the investigation is much increased by complications that arise from the inroads that are made by minute nematode worms often found preying upon the roots, and causing the development of multitudes of minute gall-like excrescences. Besides this, there are certain so-called saprophytic fungi that take advantage of the low state of vitality induced by other enemies, and do much to shorten the life of the victim. Thus, last winter it was not unusual to find the plants quite generally overrun with a species of botrytis that, when once it had obtained a foothold, was quite sure to finish the plant.

The most conspicuous fungous disease is the leaf spot (*Cercospora violæ*, Sacc.), which is quickly recognized by the large, dead, ashy spots that it produces in the leaves. In this the spores are borne upon the tips of brown projecting threads. A second fungous trouble produces straw-colored eye spots, not unlike the first-mentioned in general appearance, but very different when inspected with the microscope. This is the *Phyllosticta violæ*, Desm.

A genuine mildew (*Peronosporæ violæ*, De By.), and close of kin to that of the grape, lettuce, onion and spinach, is also one of the fatal enemies of the violet. This, while it does not produce any definite dead spots, causes the whole plant to droop and die. One of the most destructive fungi is an anthracnose (*Glœosporium violæ*, B. & Br.), which begins often at the edge of the leaf, causing an irregular discoloration that may extend its withering and blighting influence over the entire leaf. The last fungus to be here mentioned is a mould, almost as white as flour, that develops a coat upon the surface of the leaf, and sends its coarse, many-jointed filaments throughout the interior. This is a member of a genus (*Zygodesmus*) that is not gener-

ally credited with preying upon living tissues. From its extreme whiteness it has received the name of *Z. albidus*, E. & Hals.

As as illustrated bulletin is soon to be prepared upon the diseases of the violet, the subjects have only been mentioned in brief here. The remedies are not yet ready to be reported upon, but it is hoped that those who are following directions given them may obtain valuable results that will be made public.

CARNATION.

There are two leading fungous troubles of the carnation, namely, the *Septoria dianthæ*, Desm., and *Vermicularia subeffigurata*, Schw. The former is first observed upon the foliage as pinkish discolorations, which soon turn brown. The affected portion of the leaf becomes dotted over with dark pimples and then dies, while the decay spreads until the leaf is destroyed. In the second blight the base of the leaf is often the first attacked, or the stem itself between the bases of the leaves. Soon black specks appear, bearing an abundance of the spores. The two fungi often work together, and in bad cases the plants lose nearly all their green color, fail to push blooms, and are therefore worthless. Some varieties are more susceptible than others, and in many green-houses one sort will be in ruin while adjoining beds are bearing a full crop of flowers. The carbonate of copper and ammonia compound has been experimented with and good results obtained, but much depends upon taking the work in hand early in the season. There is a bacterial disease of the carnation, but it has not been studied at the Station.

MIGNONETTE.

The only fungous trouble of this floral crop has been *Cercospora residæ*, Fckl., and in some green-houses this has been quite destructive—in fact, ruining the crop. This parasite has been investigated by the Division of Vegetable Pathology, and a full account of it, with remedies, has appeared in the last annual report, with a full-page plate. Among the several remedies tested, it was found that the Bordeaux mixture proved the most effective. This, when sprayed about once per week upon the diseased plants, was quite effective.

THE BLACK KNOT OF PLUM AND CHERRY TREES.

A bulletin, No. 78, has been issued, giving an account of the nature of the black knot of plum and cherry trees, and therefore only an allusion to its contents and particular purpose will be given here. It has been shown therein, by the aid of several engravings, that the cause of the malady so fatal to plum and cherry trees is due to a fungus which, attacking the young twigs, sends its fine threads into the growing layer, and afterwards develops the conspicuous excrescences which are familiarly known as knots, galls or warts. While insects may, and usually do, inhabit the galls, especially while the latter are young and succulent, they have nothing to do with causing the trouble. It is through the dissemination of the spores formed upon the surface and within the tissue of the knots, that the disease is spread from branch to branch and tree to tree. In other words, the presence of a single knot upon one tree may be the means of spreading warts throughout a whole plum or cherry orchard. Several remedies have been tested for killing the knots, or at least arresting their further growth, and, where there are but few galls, kerosene or some other substance may be applied. But usually the better way is to cut off the warts and burn them, and if the tree is badly infested remove it entirely to the burn-heap.

It is well known that the black knot is not confined to the cultivated plum and cherry trees, but thrives as well, if not better, upon the choke cherry of the hedge-row and wood-lot, and several other species of cherry and plum. Therefore, in order to remove this contagious pest from any locality, it is necessary to destroy the warts upon the wild shrubs and trees. This can be done without any great outlay of time or money. As the knots are most conspicuous while the trees are without leaves, it follows that winter, for this and other reasons, is the most suitable time to find and destroy the pest. It is therefore urged that all land-owners, and particularly those having plum and cherry trees under cultivation, will see to it now that the necessary steps be taken to rid their localities of one of the leading enemies to fruit-growing within the State. While the black knot is a suitable subject for legislation, it is hoped that the end may be reached without the hand of the law being raised in defense of those who most desire to produce profitable crops of two of our leading fruits.

Many crop-growers throughout the State have been using remedies for various fungous enemies of crops. Space will not admit of a full account of the results obtained, and as Mr. White's are perhaps the most important, they will be presented in his own language:

REPORT BY MR. J. M. WHITE.

"My experience in spraying fruit trees and vines extends only over two seasons. In 1889 I sprayed with Climax Insect Poison to stop the work of the codling-moth and the results were favorable, yet I became satisfied that something must be done to prevent the injury by fungous diseases in order to obtain perfect fruit. Therefore, in 1890, my first application was made just before the bloom came out, and consisted of a solution of one pound of the Climax powder in one hundred gallons of water, and to this mixture was added six ounces of carbonate of copper, dissolved in two quarts of ammonia, four-strength. The spray was as fine as a dense fog, and applied so as to wet the entire tree. The second application was made immediately after the bloom had fallen, and the third in ten days after the second. After the third application the poison was omitted, and only the solution of carbonate of copper was used, and this treatment was continued at intervals of ten days to two weeks, until August 1st. I treated in this way pears, apples and grapes with good results. The benefit was most marked on Clairgeau and Deil pears, of which varieties I had been unable to obtain any good fruit for four or five years on account of leaf blight, which would cause the foliage to fall in July and August, resulting in the ruin of the fruit. This year I sprayed all except one Clairgeau tree, which was left untreated the entire season, and the result was that it (which was as good a tree as I had) became leafless in August, the fruit spotted, cracked and fell so that I did not obtain a single specimen of marketable fruit from it. All the treated trees retained their foliage and matured the finest of fruit I am confident that had I not treated them as I did I should have received no good fruit from the two varieties named, and that the entire orchard was greatly benefited. The results on apples and grapes were also noticeable. The Climax powder referred to is composed of equal parts of London purple and fine starch, so that I actually used only half a pound of poison to one hundred gallons of water, which I now think was not enough to be sufficiently effective for the moth, and another season I shall use one and a half pounds to one hundred gallons of water. I used that quantity in 1889, and in some instances slightly injured the foliage, but I prefer the larger quantity of the poison, with the chance of slight injury to the leaf, to the smaller quantity with the chance of some insects escaping uninjured. Unless the application is made in the middle of a very warm,

sunny day, I consider the danger to the foliage very slight indeed. If convenient, I should prefer a cloudy day, or the latter part of a clear one, for the application. Should there be a heavy rain immediately after spraying, it should be renewed as soon as the leaves again become dry, as much of the mixture will have been washed off. It should perhaps be mentioned here that it would be unsafe to employ Paris green if ammonia is used, because it is rendered soluble by ammonia, and would then be more liable to injure the foliage. London purple is not rendered soluble by the action of ammonia to any great extent.

"The cost of treatment will depend much upon the size of the trees or vines to be treated. In treating a pear orchard of 1,200 trees, most of which were eighteen years old, though half were dwarfs or small, each of the first three treatments cost:

For Climax powder, two packages	$0 48½
" carbonate of copper, 18 oz	62½
" 9 qts. ammonia	1 91
" labor—4 men and horse, half a day	2 50
" one treatment	$5 52
" three treatments	16 56

"Treatment with carbonate alone:

For one treatment	$5 03½
" five treatments	25 16½
Treatment for entire season	41 72½

"I estimate the treatment of an orchard of one hundred apple trees, thirty to forty years old, capable of bearing from fifteem to thirty bushels each, to be, for the first three treatments, about $15, and five treatments with carbonate alone, about $20, or $35 for the entire season. I used the field and orchard pump made by the Nixon Nozzle and Machine Co., the price of which was $85, and by using two hose, with a man to handle each, and one to work the pump, the spraying can be very rapidly performed."

This report by Mr. White contains facts that many fruit-growers desire to obtain, and also shows how the fungicides and insecticides may be employed together.

NEMATODES AS ENEMIES TO PLANTS.

VIOLETS.

During the past year, while prosecuting the study of fungous diseases of cultivated plants, several cases of serious trouble have come under my eye, and they, while not strictly matters for the bot-

anist, may merit a brief mention in this place. The violet disease was one of the uppermost subjects during the winter of 1889–90, and while examining the roots for an obscure fungus found there, it was observed that many of the fibrils were much swollen and knotty. These galls were filled with innumerable eel-worms in all stages of development, and to them the malformations of the roots were evidently due. Many violet plants were afterwards found of a dwarfed and sickly appearance, but did not show any signs of a fungus, and invariably such had many galls of various sizes and shapes upon the roots. Several growers of violets were visited and many others reached through the mails, and either from specimens examined or authentic reports, it is safe to say that the violet root galls were abundant and widespread. Two large and elaborately illustrated bulletins * have appeared during the past year upon the subject in hand, and the violet seems to be a new addition to the long list of plants attacked by the gall-forming worms.

OATS.

During July the oats throughout the State were dwarfed, the lower leaves turned brown, while the upper ones had a pale, sickly, yellow color. As the wheat, rye and grass crops were badly infested with the aphis or grain-louse during the spring, it was natural to attribute the distress among oats to the same cause, but Professor Smith assured me at the time that the aphis should not be held responsible for the failure of the oat crop. The diseased plants were therefore examined for some possible fungous disorder, but no smut, rust, mildew, mould or blight was found. The failing oat plants were also investigated by Professor Galloway, of the Department of Agriculture, who found that the trouble extended from New England to Georgia; that it attacked oats on all soils; that a bacterial germ was a constant attendant, and the disease was reproduced in healthy plants by inoculation. It only needs to be said that nematodes were found in various stages of development in the roots of sickly oats that were examined at the New Jersey Station, and they may have had something to do with the failing crop.

* "The Root Knot Diseases of the Peach, Orange and other Plants," Bulletin, No. 20, Division of Entomology, U. S. Department of Agriculture, 1889, by Dr. J. C. Neal, of the Florida Experiment Station, and "Nematode Root Galls," December, 1889, by Prof. Geo. F. Atkinson, of the Alabama Experiment Station.

CHRYSANTHEMUMS.

There were many complaints during the autumn months of the failure of the chrysanthemums to grow vigorously and bloom freely. Upon examining the plants it was seen that the lower leaves curled, turned brown and died prematurely, while later-formed leaves became brown in irregular patches, as if preyed upon by some fungous blight. Such leaves, when examined with a compound microscope, showed that they were infested with minute worms in all stages of their growth. The older dead leaves contained the same parasites in abundance also. The specimens were submitted to Professor Atkinson, who kindly reports that the nematodes are of an undescribed species, to which he proposes the name of *Aphelenchus foliicolous*, and is a truly parasitic species closely related to the genus *Tylenches*, in which are some of the most destructive of nematodes, their injuries in Europe comparing favorably with those of the genus *Heteroderma*.

COLEUS.

Last year the leaves of the coleus were badly blotched, and a superficial examination of them at the time did not reveal any signs of a fungous parasite. The knowledge of nematodes obtained during the present season suggested a re-examination, and upon a dissection of the blotches the eel-worms were brought to light, and their constant presence was demonstrated in all the many dead patches examined. The light-colored leaves are much more noticeably blotched than the dark-red ones, but all sorts seem to be the prey of the worms. Upon the roots of badly-attacked plants, many galls, some of considerable size, may be found. Professor Atkinson concludes that this is the same species as that upon the chrysanthemum.

LANTANA.

Blotches somewhat similar to those upon the coleus were found upon all the leaves of a single lantana plant—the only one in the garden. At first sight they suggested the work of a cercospora, but when examined, every blotch, large or small, contained many minute worms. The spots, as those of the coleus, were bounded by the small veinlets, and it is probable that their denser substance serves as a

check to the more rapid spread of the worms through the leaf. This is probably the same species as named for the chrysanthemum and coleus.

BOUVARDIA.

Blotches upon the leaves of the bouvardia have been quite common during the past year, and in many cases have materially interfered with the profit of the crop of flower clusters. This is another case of the destructive work of the nematodes, and according to Professor Atkinson, to whom specimens were sent, the species is probably the same as that upon the chrysanthemum and lantana. The appearance of the diseased leaves and the suffering plants is much the same in all the species attacked and no further description is needed here.

ROSES.

Sickly, stunted green-house roses have been sent to the Station and the cause for the lack of vigor was not far to seek. The roots of such plants were badly knotted and the whole root system infested with the gall-worms.

From the experience of the past year, suspicions may well be aroused whenever leaves are prematurely blotched with dead areas when no insect or fungous enemy can be found as the cause. Many interesting questions arise concerning the life history of these worms aside from the extremely practical one that naturally and properly comes up from every gardener—namely, what shall be done for the trouble? With such plants as violets and others grown in pots, it is doubtless well to use as much old mortar, plastering and other lime-containing substances as the plants will bear. In addition to this, lime-water should be applied as freely as possible. Much care needs to be taken in having the earth for potting fresh and free from the worms, and in transplanting or repotting the plants reject those that exhibit the characteristic galls upon the roots. When once the worms are in the roots, stems and leaves of the plant there is little hope of eradicating them, as they are out of the reach of external applications of remedies. Of course the refuse parts should all be removed and burned, as should whole plants when no longer worthy of keeping. If such are left to decay, the infested portions may drift into hot-beds, cold frames and the like, where the trouble may be con-

tinued and become serious. It is always well to burn all useless plants of the green-house and garden.

THE WEEDS OF NEW JERSEY.

As of the poor, it seems as if it may be said that the weeds we shall always have with us. If we could look down to the bottom of the reason of things, without doubt the eternal presence of the poor might be due in no small part to the prevalence of weeds. Every farmer, orchardist and gardener is living under a curse that has long ago found expression in the following terms: "By the sweat of thy face shalt thou eat bread." The land as well as the person who tills it is cursed with an inherited tendency to produce evil instead of good. Every fertile soil, unless regenerated by the purifying influences of clean culture, contains within it the germs of foulness. The seeds of weeds lie therein ready to spring into life and do their best to grow and yield him an abundant crop. Old land, therefore, unless it has had unusual care, is always ready to produce a tangled mass of weeds, and more than useless rubbish, because of its power to exclude valuable crops, and to perpetuate its own evil tendencies for a long time to come.

It goes without further argument that weeds are one of the greatest enemies with which crop-growers have to contend. Without weeds our fields of grain would be grain fields in fact, and not a mixture of the good with the obnoxious; our gardens would exhibit that cleanness which is the charm of every well-kept plot of ground. The physician, when first called, spends some time in determining the nature of the disease. If he is in doubt he may call in other doctors, thus illustrating the importance of first finding the seat of the disorder, that he may be able to apply the proper remedy. In like manner the land is "sick," and one of the causes is weeds. But it is not enough to say weeds, weeds; we should go further and know what weeds, know how they found their way into the soil, the conditions which favor their growth; in short, the habits of each prevailing pest, that the best remedy may be applied. Weeds differ as much among themselves as do the various crops of the farm. Some thrive under one set of conditions, and others require different treatment. Some weeds are altogether bad, and, to carry out the analogy to the sick person, usually prove fatal to good husbandry,

while others may only be an annoying drain upon the land, but do not preclude the growth of paying crops.

It is evident that the same weed is not equally bad in all soils and under all circumstances. In some parts of the State our worst weeds are encouraged because they furnish a substance for green manuring not otherwise easily obtained. Sand bur, one of the particular pests of some localities, is thus employed, and even the Canada thistle is occasionally considered a valuable addition to vineyards. Again, a weed is bad because of its influence upon the animals eating it, as is the case with wild onion, which spoils the milk and butter of dairy cows. Other weeds are harmless in every way, and the only point against them is that they are of less importance than the crop they have the power to exclude wholly or in part from the soil. Some weeds, not particularly bad in themselves, have seeds that are either provided with some means for dissemination, as wings, plumes, etc., for airy flights by means of the wind, or are of such size and shape as to not be easily separated from the seed of some crop, and therefore such weeds have more than the average means for taking possession of any soil or of becoming introduced into new localities.

A scale of points for weeds can therefore be established, by means of which any particular kind may be rated among its fellows. Because of the wide diversity of qualities among weeds, such a table of points cannot be easily established but may be arranged upon the scale of one hundred; that is, the worst possible weed under each point would take the rank of one hundred. It is not probable that any weed exists that attains to this perfect standard for badness. The tabulated form will first be given, with a few illustrations of the scoring of some familiar weeds. The figures assigned are not from any large number of observations in this State, and therefore are mainly to serve to show the scale to be applied. Those of the readers who are familiar with the method of judging animals—cattle, poultry, etc.—by employing a scale of points, will quickly notice that the present table is in some measure an application of the same principle to the scoring up or rating of the weeds. There are twenty points upon which the rating is based, and under each there are five grades, varying from one (1) to five (5), according as the weed is slightly or very bad. The last two points, 19 and 20, are combined for the convenience of accommodating an occasional point not easily classified and of more importance than any one of the points enumerated in the table. It will also be observed that point 8 is left blank, because it

is only determined by a careful series of experiments or by prolonged observation, or both, and the score here must be deferred for some time.

TABULATED SCALE OF POINTS.

		Purslane (*Portulaca oleracea*).	Ox-Eye Daisy (*Chrysanthemum Leucanthemum*).	Canada Thistle (*Cnicus arvensis*).	Narrow Plantain (*Plantago lanceolata*).	Sorrel (*Rumex Acetosella*).	Toad Flax, or "Butter-and-Eggs" (*Linaria vulgaris*).	Quack Grass (*Agropyrum repens*).	Dandelion (*Taraxacum officinale*).
1	Recognition of Seed..	4	4	4	4	3	3	5	4
2	Separation of Seed....	1	4	4	4	2	3	4	4
3	Recognition of Plant..	2	3	4	3	3	2	3	1
4	Prevalence..............	3	3	4	4	4	3	3	3
5	Robbing Soil...........	3	5	5	2	2	2	4	2
6	Seeding Capacity......	5	5	5	3	3	2	1	3
7	Dissemination..........	1	4	5	2	2	1	1	5
8	Vitality of Seed.......	?	?	?	?	?	?	?	?
9	Longevity...............	2	5	5	4	4	3	4	4
10	Root and Stem Prop'g.	0	3	5	1	1	1	5	1
11	Obnoxious Qualities..	0	3	5	1	1	0	0	0
12	Forage Value...........	4	4	5	2	4	3	3	4
13	Resist Eradication....	3	4	5	1	1	1	5	1
14	Aggressiveness.........	4	5	5	1	1	2	5	3
15	Harbor Fungi..........	1	0	0	0	0	0	1	0
16	Harbor Insects.........	0	0	0	3	0	0	0	3
17	Soil Habitat............	3	3	4	2	2	2	3	3
18	Climate Habitat.......	4	4	4	2	2	2	3	4
19, 20	Miscellaneous..........	4	5	5	4	3	2	4	1
	Total..............	44	64	74	43	38	31	54	46

The above scale of points with full explanations of its use was sent out as Bulletin 52 (March 20th, 1889), and in response to it, the following are some of the lists of twenty kinds of our worst weeds, given in the order of their vileness. They are placed here in the same order as in the table upon page 379.

BY ROBERT PALM, OF NEWARK.

1. Stellaria media............Chickweed.
2. Portulaca oleracea............Purslane.
3. Amaranthus paniculatus............Pigweed.
4. Rumex crispus............Dock.
5. Rumex Acetosella............Sorrel.
6. Anthemis Cotula............Mayweed.
7. Chenopodium album............Goosefoot.
8. Lepidium Virginicum............Pepper Grass.
9. Cnicus arvensis............Canada Thistle.
10. Cnicus lanceolatus............Thistle.
11. Polygonum tenue............Smartweed.
12. Polygonum erectum............Erect Knot Grass.
13. Polygonum hydropiper............Smartweed.
14. Polygonum Careyi............Smartweed.
15. Euphorbia maculata............Spurge.
16. Bidens frondosa............Stick Seed.
17. Capsella Bursa-pastoris............Shepherd's Purse.
18. Cynodon dactylon............Bermuda Grass.
19. Plantago major............Plantain.
20. Cerastium vulgatum............Chickweed.

In addition the following are named:

21. Chenopodium ambrosioides............Mexican Tea.
22. Plantago lanceolata............Rib Grass.
23. Asclepias Syriaca............Milkweed.
24. Chrysanthemum Leucanthemum............Ox-eye Daisy.
25. Daucus Carota............Wild Carrot.

BY J. LUDLAM, OF POMPTON.

1. Knot Grass.
2. Sourgrass, or Horse Sorrel.
3. Rattle-box Weed.
4. Dock.
5. Wild Carrot.
6. Wild Radish.
7. Yellow Daisy.
8. White Daisy.
9. Cockle.
10. Wild Buckwheat.
11. Thistles.
12. Milkweed.
13. Pigweed.
14. Ragweed.
15. Smartweed.
16. Wild Onion.
17. Burdock.
18. Devil's Flax.
19. Wild Cucumber.
20. Mullein.

BY FRANK BRUGLER, OF WARRINGTON.

1. Canada Thistle.
2. Live-for-ever.
3. Calamus.
4. Skunk Cabbage.
5. Hellebore.
6. Water Cresses.
7. Plantain.
8. Dock.
9. Smartweed.
10. Wild Sweet William.
11. Wild Carrot.
12. Horse Sorrel.
13. Golden-rod.
14. Ironweed.
15. Blue Flag.
16. Milkweed.
17. Water Mint.
18. Mayweed.
19. Chickweed.
20. Purslane.

BY MISS ANNA MAY KAIGHN, OF MOORESTOWN.

1. Ambrosia artemisiæfolia........Ragweed.
2. Capsella Bursa-pastoris........Shepherd's Purse.
3. Plantago major........Plantain.
4. Rumex crispus........Dock.
5. Rumex Acetosella........Sorrel.
6. Daucus Carota........Wild Carrot.
7. Arctium Lappa........Burdock.
8. Cnicus lanceolatus........Thistle.
9. Abutilon Avicennæ........Indian Mallow.
10. Bidens frondosa........Beggarsticks.
11. Taraxacum officinale........Dandelion.
12. Chrysanthemum Leucanthemum........Ox-eye Daisy.
13. Linaria vulgaris........Toad Flax.
14. Portulaca oleracea........Purslane.
15. Eupatorium purpureum........Trumpet Weed.
16. Polygonum Persicaria........Knotweed.
17. Phytolaca decandra........Pokeweed.
18. Malva rotundifolia........Common Mallow.
19. Datura Stramonium........Jamestown Weed.
20. Saponaria officinalis........Soapwort.

BY C. A. GROSS, OF LANDISVILLE.

1. Cenchrus trebuloides........Bur Grass.
2. Rumex Acetosella........Sorrel.
3. Lepidium Virginicum........Pepper Grass.
4. Cyperus esculentus........Galingale.
5. Portulaca oleracea........Purslane.
6. Plantago lanceolata........Rib Grass.
7. Mollugo verticillata........Carpet Weed.
8. Trefolium arvense........Rabbit-foot Clover.
9. Ambrosia artemisiæfolia........Ragweed.
10. Polygonum Persicaria........Lady's Thumb.
11. Rubus Canadensis........Low Blackberry.
12. Œnothera sinuata........Primrose.

13. Panicum capillare..Witch Grass.
14. Panicum sanguinale..Crab Grass.
15. Chrysanthemum Leucanthemum..Ox-eye Daisy.
16. Allium tricoccum ....Leek.
17. Daucus Carota.. ....Wild Carrot.
18. Erigeron Canadense ....Fleabane.
19. Cnicus arvensis.... ....Canada Thistle.
20. Chenopodium album........ ....Goosefoot.

BY MRS. J. MELICK, NEW GERMANTOWN.

1. Ambrosia artemisiæfolia.... ....Ragweed.
2. Setaria glauca and S. veridis..Foxtail.
3. Daucus Carota..Wild Carrot.
4. Bidens frondosa and B. bipinnata..Bur Marigold.
5. Cnicus arvensis ....Canada Thistle.
6. Arctium Lappa...Burdock.
7. Plantago major...Plantain.
8. Polygonum dumetorum..Wild Buckwheat.
9. Rumex Acetosella.................... ....Sorrel.
10. Rumex crispus. ....Dock.
11. Erigeron Canadensis, E. annus, E. strigosus......... ....Fleabane.
12. Chrysanthemum Leucanthemum..Daisy.
13. Convolvulus sepum..Hedge Bindweed.
14. Barbarea vulgaris..Common Water Cress.
15. Linaria vulgaris . ...Toad Flax.
16. Abutilon Avicennæ. ....Velvet-leaf.
17. Lepidium Virginicum..Wild Pepper Grass.
18. Malva rotundifolia ....Common Mallow.
19. Chenopodium album ....Goosefoot.
20. Amaranthus retroflexus and A. albus ....Pigweed.

BY GEO. W. HOWELL, OF MORRISTOWN.

1. Ox-eye Daisy.
2. Wild Carrot.
3. Wild Onion.
4. Toad Flax (Linaria vulgaris).
5. Canada Thistle.
6. Coneflower (Rudbeckia hirta).
7. Dwarf Dandelion.
8. White Plantain.
9. Black Plantain.
10. Yellow Dock.
11. Corn Cockle.
12. Chess (Bromus secalinus).
13. Mayweed.
14. Ragweed.
15. Beggarsticks.
16. Wild Mustard.
17. Knot Grass.
18. Red Root.
19. Pigweed.
20. Burdock.

BY ANNIE B. REED, OF SOMERVILLE.

1. Garlic.
2. Wild Carrot.
3. Thistle.
4. Twitch Grass.
5. Ragweed.
6. Butter-and-Eggs.
7. Ox-eye Daisy.
8. Burdock.

9. Strawberry Blite.
10. Plantain.
11. Dandelion.
12. Purslane.
13. Mayweed.
14. Aster (A. multiflorus).
15. Aster (A. miser).
16. Shepherd's Purse.
17. Mullein.
18. Moth Mullein.
19. Yarrow.
20. Poison Ivy.

BY I. P. RAND, OF VINELAND.

1. Field Sorrel.
2. Bear Grass.
3. Crab Grass.
4. Wild Carrot.
5. Knot Grass.
6. Nut Grass.
7. Ragweed.
8. Lamb's Quarters.
9. Ox-eye Daisy.
10. Poke.
11. Dock.
12. Plantain.
13. Burdock.
14. Smartweed.
15. Heart's-ease.
16. Cinquefoil.
17. Purslane.
18. Pepper Grass.
19. Mayweed.
20. Fireweed.

BY EMMA I. HACKETT, OF MANNINGTON.

1. Daucus Carota........Wild Carrot.
2. Elusine Indica........Wire Grass.
3. Allium vineale........Garlic.
4. Chrysanthemum Leucanthemum........Ox-eye Daisy.
5. Rumex Acetosella........Field Sorrel.
6. Lychnis Githago........Corn Cockle.
7. Rudbeckia hirta........Coneflower.
8. Ranunculus acris........Tall Buttercup.
9. Rhus radicans........Poison Ivy.
10. Linaria vulgaris........Butter-and-Eggs.
11. Portulaca oleraceæ........Purslane.
12. Ambrosia artemisiæfolia........Hogweed.
13. Anthemis Cotula........Mayweed.
14. Polygonum hydropiper........Smartweed.
15. Bidens frondosa........Beggar's Needles.
16. Rumex obtusifolius........Bitter Dock.
17. Bidens........Bur Marigold.
18. Brassica Sinapistrum........Wild Mustard.
19. Arctium Lappa........Burdock.
20. Cnicus pumilus........Pasture Thistle.

BY L. SCHUMACHER, OF MILLINGTON.

1. Chrysanthemum Leucanthemum........Ox-eye Daisy.
2. Erigeron strigosum........Fleabane.
3. Rumex crispus........Dock.
4. Rudbeckia hirta........Coneflower.
5. Plantago major........Plantain.
6. Pastinaca sativa........Wild Parsnip.

7. Daucus Carota	Wild Carrot.
8. Ambrosia artemisiæfolia	Ragweed.
9. Abutilon Avicennæ	Velvet-leaf.
10. Agropyrum repens	Twitch Grass.
11. Portulaca oleraceæ	Purslane.
12. Allium veneale	Wild Onion.
13. Brassica nigra	Mustard.
14. Plantago lanceolata	Rib Grass.
15. Xanthium strumarium	Cočkle Bur.
16. Taraxicum officinale	Dandelion.
17. Sicyos angulatus.	Star Cucumber.
18. Rumex Acetosella	Sorrel.
19. Stellaria media	Chickweed.
20. Rumex Acetosella (?)	Sorrel.

BY HENRY RACE, OF PITTSTOWN.

1. Cnicus arvensis	Canada Thistle.
2. Chrysanthemum Leucanthemum	Daisy.
3. Daucus Carota	Carrot.
4. Rumex crispus	Dock.
5. Ambrosia artemisiæfolia	Ragweed.
6. Chenopodium..	Pigweed.
7. Linaria vulgaris	Toad Flax.
8. Œnotheria biennis.	Evening Primrose
9. Plantago major	Plantain.
10. Asclepias Syriaca	Wild Cotton.
11. Erigeron Canadensis	Fleabane.
12. Rudbeckia hirta	Yellow Daisy.
13. Verbascum' Blattaria	Moth Mullein.
14. Anthemis Cotula	Mayweed.
15. Rubus villosus and R. Canadensis	Briars.
16. Acalypha Virginica	Mercury.
17. Agropyrum repens.	Quack Grass.
18. Arctium Lappa	Burdock.
19. Pastinica sativa	Wild Parsnip.
20. Cnicus lanceolatus	Thistle.

BY W. S. CRANE, OF CALDWELL.

1. Charlock.
2. Wild Carrot.
3. Ragweed.
4. White Daisy.
5. Dock.
6. Yellow Daisy.
7. Wild Onion.
8. Pigweed.
9. Sorrel.
10. Tall Daisy (Fleabane).
11. Nut Grass.
12. Plantain.
13. Pursley.
14. Canada Thistle.
15. Penny Cress.
16. Quack Grass.
17. Goosefoot.
18. Milkweed.
19. Indian Mallow.
20. Wild Parsnip.

BY ERNEST VOLK, OF TRENTON.

1.	Ambrosia artemisiæfolia	Ragweed, Wormwood, Hogweed.
2.	Daucus Carota	Wild Carrot.
3.	Erigeron Canadensis.	Horse or Butterweed.
4.	Rubus Canadensis.	Dewberry.
5.	Chenopodium ambrosioides.	Mexican Tea.
6.	Amarantus retroflexus.	Pigweed.
7.	Amarantus spinosus	Spiny Pigweed.
8.	Cenchrus tribuloides.	Sand Bur, Hedgehog or Bur Grass.
9.	Polygonum Pennsylvanicum	Knotweed.
10.	Capsella Bursa-pastoris	Shepherd's Purse.
11.	Ambrosia trifida	Great Ragweed.
12.	Xanthium strumarium.	Cockle Bur, or Clot Bur.
13.	Acalypha Virginica	Three-seeded Mercury.
14.	Chrysanthemum Leucanthemum.	Ox-eye Daisy.
15.	Datura Stramonium	Jamestown Weed.
16.	Arctium Lappa.	Burdock.
17.	Plantago major and P. lanceolata	Plantains.
18.	Rumex Acetosella.	Sheep Sorrel.
19.	Polygonum aviculare	Doorweed.
20.	Portulaca oleracea	Purslane.
21.	Commelina Virginica	Dayflower.
22.	Asclepias Syriaca	Cotton Weed.
23.	Diodia teres	Button Weed.
24.	Gnaphalium polycephalum	Everlasting, or Sweet Balsam.
25.	Malva rotundifolia.	Malice Weed.
26.	Abutilon avicennæ	Velvet-leaf.

The names and addresses of the observers are as follows, the number before each corresponding with that at the head of the respective columns in the table:

1.	Robert Palm	Newark.
2.	J. Ludlam	Pompton.
3.	Frank Brugler	Warrington.
4.	Anna M. Kaighn	Moorestown.
5.	C. A. Gross	Landisville.
6.	Mrs. J. Melick	New Germantown.
7.	Geo. W. Howell	Morristown.
8.	Annie E. Reed	Somerville.
9.	I. P. Rand.	Vineland.
10.	Emma S. Hackett.	Mannington.
11.	L. Schumacher	Millington.
12.	M. S. Crane	Caldwell.
13.	Henry Race	Pittstown.
14.	Ernest Volk	Trenton.

TABULATION OF THE WORST TWENTY NEW JERSEY WEEDS.

1	DAUCUS CAROTA, L. (Wild Carrot)........................
2	CHRYSANTHEMUM LEUCANTHEMUM, L. (Ox-Eye Dai
3	RUMEX ACETOSELLA, L. (Sorrel)........................
4	PLANTAGO MAJOR, L. (Plantain)........................
5	RUMEX CRISPUS, L. (Curled Dock)........................
6	**Ambrosia artemisiæfolia,** L. (Ragweed)..........
7	CNICUS ARVENSIS (L.), Hoffm. (Canada Thistle)......
8	PORTULACA OLERACEA, L. (Purslane)........................
9	ARCTIUM LAPPA, L. (Burdock)........................
10	LINARIA VULGARIS, Mill. (Toad Flax)........................
11	ALLIUM VINEALE, L. (Wild Onion)........................
12	ANTHEMUS COTULA, L. (Mayweed)........................
13	CHENOPODIUM ALBUM, L. (Goosefoot)........................
14	**Rudbeckia hirta,** L. (Yellow Daisy)........................
15	AMARANTUS CHLOROSTACHYS, Willd. (Pigweed)......
16	AGROPYRUM REPENS (L.), Beauv. (Quitch Grass)....
17	**Erigeron Canadensis,** L. (Horseweed)...............
18	**Bidens frondosa,** L. (Beggarsticks)........................
19	POLYGONUM HYDROPIPER, L. (Water Pepper).........
20	CAPSELLA, BURSA-PASTORIS, L. (Shepherd's Purse).

The botanical names in SMALL CAPITALS are of foreign species, and the **fullface** type represents native weeds.

Closely following the above twenty are:

21. Lepidium Virginicum, L .... Pepper Grass.
22. Plantago lanceolata, L.. Rib Grass.
23. Asclepias Syriaca, L.. Milkweed.
24. Taraxacum officinale, Web.. Dandelion.
25. Cenchrus tribuloides, L.. Bur Grass.
26. Lychnis Githago (L.), Lam.. Corn Cockle.
27. Abutilon Avicennæ, Gærtn.. Velvet-leaf.
28. Cnicus lanceolatus (L.), Willd .... Thistle.
29. Stellaria media (L.), Smith .... Chickweed.
30. Brassica nigra (L.), Koch.. Black Mustard.

The following are some of the partial lists not including twenty or more different kinds, but fully as valuable as the longer enumerations, so far as the first few worst weeds are concerned:

BY C. M. DALRYMPLE, OF KINGWOOD.

1. Chrysanthemum Leucanthemum.. Daisy.
2. Cnicus arvensis.. Canada Thistle.
3. Verbascum Blattaria.. Moth Mullein.

4. Plantago major........Common Plantain.
5. Arctium Lappa........Burdock.
6. Daucus Carota........Carrot.
7. Pastinica sativa........Parsnip.
8. Polygonum hydropiper........Smartweed.
9. Ambrosia artemisiæfolia........Ragweed.
10. Portulaca oleracea........Purslane.
11. Rudbeckia hirta........Coneflower.
12. Lychnis Githago........Corn Cockle.
13. Xanthium strumarium........Cockle Bur.
14. Bromus secalinus........Cheat Grass.
15. Verbascum Thapsus........Mullein.

BY BERNARD ACKERMAN, OF WYCKOFF.

1. Canada Thistle.
2. Bellweed.
3. Virginia Weed.
4. Wild Parsnip.
5. Black Plantain.
6. Golden-rod.
7. Ragweed.
8. Crab Grass.
9. Burdock.
10. Wild Onion.
11. Wild Tobacco, or Mullein.
12. Daisies.

BY J. M. RANDALL, OF EAST ORANGE.

1. Chickweed.
2. Purslane.
3. Dandelion.
4. Plantain.
5. White Daisy.
6. Wild Mustard.
7. Dock.
8. Sorrel.

BY RACHEL C. PERRY, OF PEAPACK.

1. Cnicus arvensis.
2. Ambrosia trifida.
3. Ambrosia artemisiæfolia.
4. Triticum repens.
5. Sinapis arvensis
6. Erigeron strigosum.
7. Malva rotundifolia.
8. Portulaca oleracea.

BY D. C. VOORHEES, OF BLAWENBURG.

1. Canada Thistle.
2. Wild Mustard.
3. Buzzard Weed.
4. Plantain.
5. Daisy.
6. Wild Carrot.
7. Smartweed.
8. Crab Grass.
9. Sorrel.
10. Ragweed.

To show how thoroughly the work has been entered upon by some of the practical botanists and others of the State, as well as to put their valuable work in this direction on record, the following joint paper is presented in as full a form as space will permit:

SUSSEX COUNTY WEEDS.

BY HON. THOMAS LAWRENCE AND PROF. WM. M. VAN SICKLE.

Weeds may be classified into those infesting the land generally, and those abounding particularly in gardens. Of the former class, Canada thistle, blueweed, wild carrot, ox-eye daisy, common sorrel and ragweed give the most trouble to the agriculturists of Sussex county. Canada thistle has never made any great headway here, but there is scarcely a farm entirely exempt from it. In meadow and upland it has seeded itself here and there in small patches, but as the years come and go the farmer endeavors to eradicate the dire pest from the land. These efforts are attended with a measure of success. In some sections of our country Canada thistle has almost absolute possession of the ground, to the exclusion of all other herbage. The writers have seen acres of good farming soil in some parts of Pennsylvania and New York where nothing else grew. Such spectacles behoove the most careful scrutiny in keeping this weed under subjection. Its foothold is to be dreaded with great alarm. Various means are taken for the extermination of this weed, and all with varied success. Cutting just when the stalk or stem becomes hollow, so that the rains descend in the little tubes formed, producing early decay, is one of the best modes of killing the thistle. Nothing, however, has been so successful as the growing on tillable fields of several crops in succession. This practically destroys all the living plants and germinating seeds.

Blueweed is not a native plant of the State. Its introduction into the county dates back about a third of a century. A tradition is current that a band of traveling gypsies brought the weed here with some oats which they carried along for feeding their horses. The plant possesses all the obnoxious qualities of the Canada thistle, and is called in this vicinity, Virginia thistle. Blueweed is found principally in the Vernon Valley, in the townships of Hardyston and Vernon. It is an abundant seeder, bearing flowers from early summer until the frosts of autumn. On this account it spreads very rapidly when left undisturbed. It is a plant of luxurious growth, and will crowd out growing crops of oats and buckwheat, therefore the imperative necessity of exterminating the weed from the county. For this, as for the Canada thistle, many ways have been tried. Pulling the plant bodily, root and all, from the ground at any time

before the seeds have ripened, is the best-known means of extermination. Of course, this is a matter of easy labor where blueweed is confined to small limits; but, on the other hand, where fields of it abound, some more practical way must be devised.

Wild carrot is a prolific weed in all parts of the country and is found on all kinds of soil. Meadows and grazing fields are the worst afflicted by it. Towering above the aftermath of the early-mown meadows stand the blossoms of the carrot like a field of snow. The picture is pretty to behold, yet the damage wrought by the weed can in no way be compensated by its beauty. It is a pestiferous weed of one of the worst types. Any practical remedy for totally destroying the plant would be hailed with joy.

Ox-eye daisy is a very common weed among us and is known by old and young. Fields are frequently white with it, especially meadows and pastures. It is difficult to eradicate. So general is the weed that most farmers pass it by unnoticed; however, all unite in conceding that it is of much value for forage. It is a gregarious plant and seeks to occupy the whole face of the earth.

Common sorrel, like ox-eye daisy, is a common weed in Sussex. From the knowledge of the writers it should doubtless be given a higher rating than 38, the grade accorded it in the official bulletin issued last March. The State Botanist therein says: "The writer's experience, that enriching the soil will aid greatly in driving out this pest when the crop is well tilled, leads him to give a low rating to this weed." True, enriched soil is not the natural home of the sorrel. On sandy, gravelly hills the plant seems to thrive at its best and "is frequently an index of a soil not being able to bear profitable crops without manure or fertilizer." The writers have seen, however, acres of the finest land in the Kittatinny Valley covered with sorrel to the exclusion of grass or pasture. Climate is a ruling power. During the excessively dry seasons of a few years ago, farmers experienced no little difficulty in getting grass seeds to take. Hundreds of bushels of clover and timothy seed were sown on the fertile fields of Sussex without any return for the work. But sorrel came and flourished. In many fields it was the abundant crop of the time. It could not be driven away. Year after year it made its appearance on hill and dale. Farmers grumbled and complained, but still the sorrel came. The dryless seasons of the past two summers have thrown a wet blanket upon the face of the earth, from which has sprung forth an

abundant crop of grasses, crowding out the sorrel from its abiding-place.

Ragweed is known by all our people. It grows in abundance on the harvested grain field, which seems to be its natural habitat. As a forage plant it is not of much use. Swine eat it to some extent, but as a food for milch cows it gives a bad taste and odor to the milk and butter. On this account it is mainly that the farmers consider the weed obnoxious. Ragweed grows rapidly on stubble fields, but does in no way retard or appear to hinder the undergrowing young clover and timothy. However, from its rank growth it must certainly be a great consumer of the fertilizers in the rich soils which it so profusely covers. If that be true, then this plant takes the rank of bad eminence and richly deserves all the harsh words ever uttered against it.

These weeds which the writers have briefly described, while ranking among the worst, do not by any means include the host of others which seem to grow and multiply for no higher purpose than annoyance to him who earns his bread by the sweat of his face.

Common mullein, skunk cabbage, five-finger, wild buckwheat, burdock and charlock, are too well known to require long descriptions.

Mullein, with us, seeks the brows and summits of ridges and knolls, where it not infrequently attains the height of three or four feet. Ex-Senator Lawrence thinks that this weed does not rob the soil of its sustenance and strength as much as generally believed.

Skunk cabbage is confined to the lowlands, and its habitat is wet soil. In early spring it begins to shoot forth its leaves, which develop into mammoth size, covering the ground, and therefore occupying considerable valuable space where grass would otherwise grow. On bottom meadows, near running streams, it does great destruction to the annual hay crop. It is a bad weed.

Five-finger thrives best on a poor soil, and is the best sort of an index that the soil needs a good coat of manure.

Wild buckwheat is one of the worst weeds in gardens and cornfields, and is difficult to eradicate. Its seed undoubtedly possess great vitality and will germinate after having lain in the ground for years. Poorly cultivated cornfields which have not been tilled for a number of years, have been overrun with this bad weed, thus showing that the seed can lie in a latent state for a long term of years.

Burdock is a vile pest and is common in manured places and barn-yards, but is kept under subjection by most of the farmers of the country. The ugly burs from this plant, which fasten themselves to all kinds of animals, giving them an unsightly appearance, are the greatest objection to the weed. On this account farmers have been literally forced to keep the plant from spreading. There is no great amount of it in Sussex, and what there is can be found chiefly in neglected places. Its destruction is accomplished chiefly by repeated cuttings or by digging it out bodily by the roots.

Charlock is a species of mustard, and is generally known in this locality as wild mustard. It is found mostly in cultivated fields, and no effort has been made to eradicate it except the consequent tilling of the soil where it abounds. It certainly is a troublesome weed and its riddance would be a blessing.

Butter-and-eggs, toad flax, wild flax, Hessian weed, or ramsted, is a plant known by all these several names in different localities. It is a naturalized pest from Europe, and abounds in fields and along roadsides. It bears a dense raceme of yellow flowers throughout the summer. Butter-and-eggs is very widely diffused in Sussex and its habitat is a fertile soil.

Among the vile pests infesting gardens, giving great labor and annoyance to the gardener, may be named pigweed, common purslane, common mallow, cockle bur and the several varieties of chickweed. Much of the labor expended on the truck patch, the family's resort for table vegetables, goes toward keeping the weeds from overrunning the potatoes, corn, beans and peas.

Many of the vilest of vile weeds are naturalized from Europe, and were introduced into this country by the early pioneers for commercial, medicinal or æsthetic purposes. Some were grown for their roots, others for their herbage. In our forefathers' garret, hanging high on the rafters, were the garnered herbs, horehound, catnip, smartweed and a multitude of others, for each of which our good old grandmothers knew some particular use.

In looking over the well-written pages of an old and carefully-preserved memoranda-book of sundry transactions, kept by Thomas Lawrence, Esq., Judge of the Court of Common Pleas, and grandfather of the senior writer of this article, a record was found showing that weeds were grown on the fields of Sussex in the early part of this century for some unknown use. Following is the minute of the

record made bearing date of May 3d, 1813: "Received this day from Charles Whitlow, the botanist, forty dollars, to defray the expense of procuring the thistle-plant, and for cultivating the same."

This language speaks for itself, but leaves the writers in darkness in regard to Charles Whitlow, further than his profession. But that the money was actually received and applied for the purpose designated, is a matter of fact. The record shows that thirty-five dollars and fifty cents were expended for labor, one dollar of which was for one quart of good old Jersey apple-jack for the use of the laborers. The balance of the money was doubtless refunded to Prof. Whitlow.

It may be that the thistle-plant so abundant along the Wallkill, below Hamburg, and regarded as a pest by all the land-holders in that region, gained its first foothold from the crop grown by Judge Lawrence, seventy-six years ago. Be that, however, as it may, it is certain that many pestiferous plants were thus introduced.

Below are submitted answers to the series of twelve questions promulgated by the State Botanist in the bulletin of March, 1889, together with such questions. The answers given apply to the county of Sussex:

1. What are your worst weeds? (Please write the names as far as possible in the order of their badness.)

Canada Thistle.
Blueweed.
Wild Carrot.
Ox-eye Daisy.
Ragweed.
Five-finger.
Wild Buckwheat.
Cockle Bur.
Horse Sorrel.
Common Mullein.
Skunk Cabbage.
Round-leaved Mallow.
Charlock.
Burdock.
Butter-and-Eggs.
Common Purslane.
Common Plantain.
Common Pigweed.

2. What kinds of weeds are known by more than one name? (Please write only the names of the same plant upon the same line.)

Blueweed, Virginia Thistle, Viper's Bugloss, Blue Devils, *Echium vulgare;*
Ox-eye Daisy, White Daisy, *Chrysanthemum Leucanthemum;*
Ragweed, Hogweed, *Ambrosia artemisiæfolia;*
Horse Sorrel, Common Sorrel, *Rumex Acetosella;*
Charlock, Wild Mustard, *Brassica arvensis;*
Butter-and-Eggs, Toad Flax, Wild Flax, Hessian Plant, Ramsted, *Linaria vulgaris.*

3. Have you any new weeds in your land? How were they introduced?

There are a number of new weeds in the county, but not having a botanical analysis of them, the writers reserve the subject for a future article.

4. Are your weeds more destructive than ten or more years ago?

The observable difference during the past decade is not so easily estimated, but weeds are much more numerous and infinitely more destructive than they were a half century ago. At that time very little difficulty was encountered in the way of weeds.

5. What is the estimated expense per year of your weeds to you?

This is a difficult question to answer, but it is presumed that fifteen per cent. of the total cost or expenditure of labor in the production of all kinds of crops on tilled lands is a fair estimate of the amount of such labor for weeds alone. Much of the plowing and cultivating of growing crops is necessitated by the pestiferous weeds infesting the lands. This fact needs no proof; it is known by all tillers of the soil.

6. What precautions have you used in keeping weed seeds out of your soil?

No special pains have been taken by the average farmer other than cutting yearly before the seeds are matured, the most noxious weeds, such as Canada thistle and blueweed. A few progressive farmers, who delight in seeing their farms neat and trim, without bush or bramble, brier or weed, have sought to keep the worst types of weeds eradicated from their domains. Their efforts have been attended with some success. The precaution they employ is simply cutting the weeds before the seeds ripen.

7. Do you make it a practice to burn weeds?

The burning of weeds is chiefly confined to garden lots, and then the most is done in the spring of the year, prior to plowing the ground. It is true that an occasional farmer burns the weeds, brush and briers mown along the waysides and fences, but such farmers are the exception rather than the rule.

8. Have you employed any remedies, as salt, lime, kerosene, etc., for killing weeds? What was found best, and for what weeds?

Various remedies have been tried for the extermination of weeds, including the whole category herein named, but the success attending their application does not commend them to general use.

9. Are the roadways and fence corners kept clean of weeds?

It is a sad encomium for Sussex to answer this question in the negative, but the facts seem to corroborate such an answer. But more attention in recent years has been given to keeping the fences, particularly along the highways, freed from weeds than formerly. This certainly is encouraging.

10. Have you observed any relation between kinds of soil and certain weeds?

As a matter of fact this can be easily answered in the affirmative. The natural habitat of thousands of plants is on the lowlands, in the black soil; whereas, on the other hand, many plants seem suited simply for the highlands and will not flourish elsewhere.

11. Do you think that a State Weed law would be of service in your neighborhood against impure seed? against neglected waysides, fence corners, or even cropped fields?

It is difficult to regulate such matters by legislative enactments. Here is the wording of the existing statute, approved over forty years ago:

"If any person or persons owning, possessing, or having care or charge of any land or lands, improved or unimproved, enclosed or unenclosed, in this State, shall knowingly, willingly or willfully permit or suffer any Canada thistle to grow up thereon, and suffer the same to stand until its seeds get ripe, he, she or they shall, for every stalk or branch thereon, so suffered to grow up, forfeit and pay a fine of twenty-five cents, to be sued for and recovered, with costs, by any person, in his name, before any court of competent jurisdiction."

By an act passed several years ago it is made the duty of all Road Overseers to keep the brush, weeds or briers cut along all the public highways. What is the force of these two acts? Are their provisions enforced? Do they meet the purpose for which they were enacted? By common consent they are disregarded. There is no need of further legislation on the subject so long as existing laws remain inoperative. This statement carries with it its own argument and is a bulwark in support of the writers' position.

12. Have you any worse enemy to your crops than weeds, that come within the scope of the Station Botanist?

There may be no worse enemy; however, scrub-oak, low blackberry and poison ivy demand some attention. It is a fact well known that when yellow-pine ridges or lands are shorn of their trees, scrub-oak takes the place of the once growing pines, and is extremely difficult to eradicate. If some means could be devised for the death of every scrub-oak, no farmer on whose lands it grows would grumble at a reasonable expenditure of money for that purpose.

Low blackberry is very widely diffused, and when once having found a foothold, remains with willful persistence. The destruction of these pesky briers may be secured by tilling the soil where they are found, for a number of years in succession. On meadows and pastures, mowing twice during the season, with the machine set low, has proved of service.

Poison ivy is particularly dreaded on account of its touch, to many people, being poisonous.

The fungi of plants open a field for interesting observation. During the last year, owing to the wet season, the potato crop in this county was badly damaged by fungi. Bush beans suffered from the same cause, and in many gardens was not more than half a crop.

HAMBURG, Sussex county, Nov. 27th, 1889.

PRELIMINARY LIST OF THE WEEDS OF NEW JERSEY.

The plants herein enumerated, either frequently or always, occupy the land to the exclusion of more useful species, and are therefore known as weeds. It is often difficult to decide whether a certain species should go into this preliminary list and therefore some are included which are not much more destructive or annoying than many others that have been omitted. The list is made quite inclusive, and some members may perhaps be dropped when their habits are better known. If any species, not herein mentioned, is a decided pest in the State, it is desired that it be reported and the list become as complete as possible. It would greatly increase the value of this paper if localities could have been given under each species, but this at present is not possible. It is, however, hoped that the range of our worst weeds, at least, may be determined in the near future.

Weeds are divided into two classes, whether native or introduced

from other countries. This distinction is shown by the foreign members being printed in SMALL CAPITALS, while our own species are set in **fullface type**. Thus, **Cnicus odoratus**, the pasture thistle, is a native of the State, while CNICUS ARVENSIS, the Canada thistle, is from abroad. The species are again divided into three groups. The first includes those which are universally known as aggressive weeds. These not only hold what land they secure, but make a strong fight for the possession of new territory. This hostile character is indicated by the numeral one in the parenthesis (1) following the common name or names of the species. The second group includes plants which are less annoying to the farmer and gardener, but have a weedy habit and are rarely of service for forage or other purposes. Thus, SISYMBRIUM OFFICINALE, Hedge Mustard, (2), is a foreign species of this group which inhabits wet places and often covers low areas with a comparatively worthless herbage, but rarely excludes more valuable plants on higher and drier ground. In this it is quite different from its near relative, the ubiquitous Shepherd's Purse, which ranks among the first class (1) as a troublesome pest in the most valuable soil of the garden. In the third class (3) is placed a host of plants many of which are of a negative character—they are neither good nor very bad, of little value and will usually succumb easily under the conditions of ordinary culture. The Mandrake (**Podophyllum peltatum**, L.) may be taken as an average native species of this class, while next to it in the list is CHELODONIUM MAJUS, L., Celandine, (3), an introduced species. Both grow in moist, shady places and may cover considerable areas with an unprofitable herbage, but never encroach upon a cultivated field.

The words following the number indicate, in a general way, the place where the plant most frequently abounds, and the capital letter at the end shows whether the species is an annual (A.), a biennial (B.), or a perennial (P.) Some of the so-called biennial plants may be either annuals or perennials, according to circumstances. Some of the A.'s and P.'s may also vary, and therefore the index of longevity is given with limitations.

The reader will at once appreciate the difficulty connected with placing many of the species in one of the three groups. Frequently the plant is almost upon the line, and further knowledge will doubtless change its position. Bear in mind, however, that the list is for New Jersey only.

The list is arranged by families according to the classification of the

orders in Gray's Manual. This brings near each other all species that are closely related. Any other plan is quite sure to widely separate the members of the same genus and the arrangement becomes entirely artificial. Especial effort has been made to obtain the common names of the various kinds of weeds and they are brought together as synonyms following the scientific name. This double name, which is the only reliable basis for classification, because it rests upon a full, recorded botanical description, has been placed first because it is the compound term by which the species is known to all scientific students of plants in all languages and parts of the world. A common name at best arises by common consent and bears with it all the possibilities of confusion attached to such undefined terms. For example, "none-such" to one may be "medick" to another, and "medicago" to others. "Daisy" is a general term applied to a score of species. The plant called "fireweed" in one section may be known only as "wild lettuce" in another. Viper's bugloss has several other names, and this is true of dozens of weeds, if not of nearly all, if the whole history of field and garden nomenclature and folk-lore on the subject were known. On account of the confusion incident to the growth of common terms applied to common plants it is hoped that any names of weeds not in the alphabetical list will be sent for addition thereto. There are doubtless many local names which should be secured. A portion of the plant itself should accompany the term, that the latter may find its proper place in the classified list of species, where it will become an added synonym.

In the alphabetical index of common names reference is made by number to the species with which it has been associated or to which it is locally or occasionally applied.

PRELIMINARY LIST OF NEW JERSEY WEEDS.

RANUNCULACEÆ, CROWFOOT FAMILY.

1. **Thalictrum dioicum,** L.—Early Meadow Rue, (3), meadows and pastures, (P.)
2. **Thalictrum polygamum,** MUHL.—Tall Meadow Rue, (3), wet meadows, (P.)
3. **Thalictrum purpurascens,** L.—Purple Meadow Rue, (3), wet meadows, (P.)
4. RANUNCULUS REPENS, L.—Creeping Buttercup, (3), wet meadows, (P.)
5. RANUNCULUS BULBOSUS, L.—Bulbous Buttercup, (2), pastures, (P.)
6. RANUNCULUS ACRIS, L.—Tall Crowfoot Buttercup, (2), pastures, (P.)

BERBERIDACEÆ, BARBERRY FAMILY.

7. **Podophyllum peltatum**, L.—Mandrake, May-apple, Hog-apple, (3), woodland pastures, (P.)

PAPAVERACEÆ, POPPY FAMILY.

8. CHELIDONIUM MAJUS, L.—Celandine, (3), moist, waste ground, (P.)

CRUCIFERÆ, MUSTARD FAMILY.

9. **Nasturtium palustre**, D. C.—Marsh-cress, (3), wet places, (B.)
10. NASTURTIUM ARMORACIA (L.), FRIES.—Horseradish, (3), neglected gardens, (P.)
11. **Hesperis matronalis**, L.—Dame Rocket, (3), rich waste ground, (P.)
12. BRASSICA ALBA (L.), BOISS.—White Mustard, (2), neglected soil, (A.)
13. BRASSICA NIGRA (L.), KOCH.—Black Mustard, (2), neglected soil, (A.)
14. BRASSICA ARVENSIS (L.), B. S. P.—Charlock, Yellow Mustard, (1), grain and stubble fields, (A.)
15. BRASSICA CAMPESTRIS, L.—Turnip, (2), cultivated fields, (B.)
16. **Barbarea vulgaris**, R. BR.—Yellow Rocket, (3), waste, moist places, (B)
17. SISYMBRIUM OFFICINALE (L.), SCOP.—Hedge Mustard, (2), moist places, (A.)
18. SISYMBRIUM THALIANA (L.), GAY.—Mouse-ear-cress, (2), sandy fields, (A.)
19. CAMELINA SATIVA, CRANTZ.—False Flax, (3), cultivated fields, (B.)
20. CAPSELLA BURSA-PASTORIS, MŒNCH.—Shepherd's Purse, (1), cultivated and waste ground, (A.)
21. **Lepidium Virginicum**, L.—Pepper Grass, (2), neglected ground, (A.)
22. LEPIDIUM CAMPESTRE (L.), R. BR.—Field Pepper-grass, (1), neglected ground, (A.)
23. RAPHANUS RAPHANISTRUM, L.—Wild Radish, Jointed Charlock, Rape, (1), cultivated ground (A.)

VIOLACEÆ, VIOLET FAMILY.

24. **Viola cucullata**, AIT.—Blue Violet, (3), low grass land, (P.)

HYPERICACEÆ, ST. JOHN'S-WORT FAMILY.

25. HYPERICUM PERFORATUM, L.—St. John's-wort, (2), meadows and pastures, (P.)

CARYOPHYLLACEÆ, PINK FAMILY.

26. SAPONARIA OFFICINALIS, L.—Bouncing Bet, (2), waste ground, (P.)
27. SAPONARIA VACCARIA, L.—Cow-herb, (2), waste places, (A.)
28. SILENE INFLATA, SMITH.—Bladder Campion, (2), waste ground, (P.)
29. SILENE ARMERIA, L.—Sweet William, (2), waste places, (A.)
30. LYCHNIS GITHAGO (L.), LAM.—Corn Cockle, (1), grain fields, (A.)
31. LYCHNIS VESPERTINA, SIBTH.—Evening Lychnis, Cockle, (2), waste ground, (B.)
32. ARENARIA SERPYLLIFOLIA, L.—Thyme-leaved Sandwort, (3), waste sandy soil, (A.)
33. STELLARIA MEDIA (L.), SMITH.—Chickweed, (1), shady moist ground, (A.)
34. CERASTIUM VISCOSUM, L.—Mouse-ear Chickweed, (2), open fields, (P.)
35. SPERGULA ARVENSIS, L.—Corn Spurrey, (2), grain fields, (A.)

PORTULACACEÆ, PURSLANE FAMILY.

36. PORTULACA OLERACEA, L.—Purslane, Pusley, (1), cultivated gardens, (A.)

MALVACEÆ, MALLOW FAMILY.

37. MALVA ROTUNDIFOLIA, L.—Round-leaved Mallow, Cheeses, Mallard, (2), waste shady ground, (P.)
38. SIDA SPINOSA, L.—Sida, (2), neglected ground, (A.)
39. ABUTILON AVICENNÆ, GÆRT.—Velvet-leaf, Butter-print, (1), cultivated soil, (A.)
40. HIBISCUS TRIONUM, L.—Bladder Ketmia, (2), cultivated ground, (A.)

LINACEÆ, FLAX FAMILY.

41. LINUM USITATISSIMUM, L.—Flax, (3), dry meadows, (A.)

GERANIACEÆ, GERANIUM FAMILY.

42. **Geranium maculatum,** L.—Spotted Cranesbill, (3), dry grass land, (P.)
43. **Geranium Carolinianum,** L.—Cranesbill, (3), waste places, (A.)
44. ERODIUM CICUTARIUM (L.), L'HER.—Storksbill, (3), waste places, (A.)
45. **Impatiens aurea,** MUHL.—Pale Touch-me-not, (3), wet places, (A.)
46. **Impatiens biflora,** WALT.—Spotted Touch-me-not, (3), wet places, (A.)
47. **Oxalis corniculata,** *var.* **stricta** (L.), SAV.—Yellow Wood Sorrel, (3), grass land, (P.)

ANACARDIACEÆ, CASHEW FAMILY.

48. **Rhus radicans,** L.—Poison Ivy, Poison Oak, (2), moist shady places, (P.)
49. **Rhus glabra,** L.—Smooth Sumac, (3), neglected ground, (P.)

LEGUMINOSÆ, PULSE FAMILY.

50. **Crotalaria sagittalis,** L.—Rattle-box, (3), pastures, (A.)
51. **Trifolium repens,** L.—White Clover, (3), cultivated ground, (P.)
52. TRIFOLIUM PROCUMBENS, L.—Low Hop Clover, (2), cultivated ground, (A.)
53. TRIFOLIUM ARVENSE, L.—Rabbits-foot Clover, (2), poor soil, (A.)
54. TRIFOLIUM AGRARIUM, L.—Yellow Hop Clover, (2), cultivated ground, (A.)
55. MELILOTUS OFFICINALIS (L.), LAM.—Melilot, Yellow Sweet Clover, (3), neglected ground, (A. and B.)
56. MELILOTUS ALBA, L.—White Melilot, (2), waste ground, (A. and B.)
57. MEDICAGO LUPULINA, L.—Nonesuch, Black Medick, Medicago, (2), neglected ground, (B.)
58. VICIA SATIVA, L.—Common Vetch, or Tare, (2), cultivated land, (A.)
59. **Lespedeza frutescens** (WILLD.), ELL.—Bush Clover, (3), dry grass land, (P.)

ROSACEÆ, ROSE FAMILY.

60. **Rosa humilis,** MARSH.—Dwarf Wild Rose, (2), dry grass land, (P.)
61. **Agrimonia Eupatoria,** L.—Common Agrimony, (3), shady places, (P.)
62. **Potentilla Norvegica,** L.—Norway Cinquefoil, Five-finger, (3), grassy places, (B.)

63. **Potentilla Canadensis,** L.—Cinquefoil, Slender Five-finger, (3), dry grass land, (P.)
64. **Rubus strigosus,** MICHX.—Wild Red Raspberry, (3), waste places, (P.)
65. **Rubus villosus,** AIT.—High Blackberry, Bramble, (3), waste places, (P.)
66. **Rubus occidentalis,** L.—Black-cap, Thimble Berry, (3), waste places, (P.)

CRASSULACEÆ, ORPINE FAMILY.

67. SEDUM TELEPHIUM, L—Live-for-ever, (2), cultivated ground, (P.)

ONAGRACEÆ, EVENING PRIMROSE FAMILY.

68. **Epilobium spicatum,** LAM.—Great Willow-herb, Fire-weed, (3), cleared land, (B.)
69. **Epilobium coloratum,** MUHL.—Smaller Willow-herb, (3), wet places, (P.)
70. **Œnothera biennis,** L.—Common Evening Primrose, (2), dry grass land, (B.)

CACTACEÆ, CACTUS FAMILY.

71. **Opuntia vulgaris,** HAW.—Prickly Pear, Indian Fig, (3), dry land, (P.)

CUCURBITACEÆ, GOURD FAMILY.

72. **Sicyos angulatus,** L.—Star Cucumber, (3), low ground, (A.)

UMBELLIFERÆ, PARSLEY FAMILY.

73. DAUCUS CAROTA, L.—Carrot, (1), meadows and pastures, (B.)
74. **Heracleum lanatum,** MICHX.—Cow Parsnip, Master-wort, (2), moist places, (P.)
75. PASTINACA SATIVA, L.—Parsnip, (1), grass land, (B.)
76. **Thaspium aureum** (L.), NUTT.—Meadow Parsnip, (3), moist land, (P.)
77. CONIUM MACULATUM, L.—Poison Hemlock, (3), moist ground, (B.)

RUBIACEÆ, MADDER FAMILY.

78. **Diodia teres,** WALT.—Button-weed, (3), dry waste places, (A.)

DIPSACEÆ, TEASEL FAMILY.

79. DIPSACUS SYLVESTRIS, MILL.—Teasel, (3), waste places, (B.)

COMPOSITÆ, SUNFLOWER FAMILY.

80. **Vernonia Noveboracensis** (L.), WILLD.—Iron-weed, (2), low pastures, (P.)
81. **Eupatorium purpureum,** L.—Trumpet-weed, Joe-pye Weed, (2), low land, (P.)
82. **Eupatorium perfoliatum,** L.—Boneset, Thoroughwort, (2), low ground, (P.)
83. **Aster Novæ Angliæ,** L.—New England Aster, (3), moist ground, (P.)
84. **Aster ericoides,** L.—Heath-like Aster, (3), poor soil, (P.)
85. **Aster lateriflorus** (L.), BRITT.—Starved Aster, (3), poor soil, (P.)

86. **Aster cordifolia,** L.—Heart-leaved Aster, (3), shady places, (P.)
87. **Aster patens,** AIT.—Spreading Aster, (3), dry ground, (P.)
88. **Aster umbellatus,** MILL.—Umbellate Aster, (3), moist ground, (P.)
89. **Erigeron Canadensis,** L.—Horse-weed, Fleabane, Colt's Tail, (1), waste ground, (B.)
90. **Erigeron annuus** (L.), PERS.—Daisy Fleabane, Sweet Scabious, (1), neglected ground, (A.)
91. **Erigeron Philadelphicus,** L.—Common Fleabane, (2), moist places, (P.)
92. **Erigeron ramosus** (WALT.), B. S P.—Rough-stemmed Fleabane, (2), dry ground, (B.)
93. **Erigeron bellidifolius,** MUHL.—Robin's Plantain, (3), wet places, (P.)
94. **Solidago Canadensis,** L.—Canada Golden-rod, (2), grass land, (P.)
95. **Solidago serotina,** AIT.—Late Golden-rod, (2), grass land, (P.)
96. **Ambrosia trifida,** L.—Horse-weed, Great Ragweed, (1), neglected ground, (A.)
97. **Ambrosia artemisiæfolia,** L.—Ragweed, Roman Wormwood, Hogweed, Bitterweed, (1), neglected ground, (A.)
98. **Xanthium Canadense,** *var.* **echinatum** (MURR.), GRAY.—Clotbur, Cocklebur, (1), neglected ground, (A.)
99. XANTHIUM STRUMARIUM, L.—Cocklebur, Clotbur, (1), waste places, (A.)
100. XANTHIUM SPINOSUM, L.—Spiny Cocklebur, Clotbur, (1), waste places, (A.)
101. **Rudbeckia laciniata,** L.—Cut-leaved Coneflower, (2), shady places, (P.)
102. **Rudbeckia hirta,** L.—Yellow Daisy, or Coneflower, (1), grass land, (P.)
103. HELIANTHUS ANNUUS, L.—Common Sunflower, (3), cultivated ground, (A.)
104. **Helianthus divaricatus,** L.—Forked Sunflower, (3), dry places, (P.)
105. **Helianthus tuberosus,** L.—Jerusalem Artichoke, Tuberous Sunflower, (2), low places, (P.)
106. **Bidens frondosa,** L.—Bur Marigold, Stickseed, Pitchforks, Beggarsticks, (1), neglected ground, (A.)
107. **Bidens lævis** (L.), B. S. P.—Beggarsticks, Bur Marigold, (2), moist places, (A.)
108. **Bidens connata,** MUHL.—Swamp Beggarsticks, Marigold, (2), moist places, (A.)
109. **Bidens cernua,** L.—Small Beggarsticks, Bur Marigold, (2), wet ground, (A.)
110. **Bidens bipinnata,** L.—Spanish Needles, (2), damp soil, (A.)
111. GALINSOGA PARVIFLORA, CAV.—Galinsoga (3), waste places, (A.)
112. ANTHEMIS COTULA, L.—Mayweed, Dog Fennel, (1), waste places, (A.)
113. ANTHEMIS ARVENSIS, L.—Corn Chamomile, (1), waste places, (A.)
114. **Achillea millefolium,** L.—Milfoil, Yarrow, (2), grass land, (P.)
115. CHRYSANTHEMUM LEUCANTHEMUM, L.—Ox-eye Daisy, Bull's-eye, (1), grass land, (P.)
116. CHRYSANTHEMUM PARTHENIUM (L.), PERS.—Feverfew, (1), waste places, (P.)
117. TANACETUM VULGARE, L.—Tansy, (2), neglected places, (P.)
118. **Artemesia biennis,** WILLD.—Biennial Wormwood, (3), dry places, (B.)
119. **Artemesia vulgaris** (L.), NUTT.—Mugwort, (3), dry places, (P.)
120. **Gnaphalium obtusifolium,** L.—Cudweed, Everlasting, (3), dry places, (P.)
121. **Antennaria plantaginifolia,** HOOK.—Plantain-leaved Everlasting, (3), dry places, (P.)

122. INULA HELENIUM, L.—Elecampane, (2), waste places, (P.)
123. **Erechthites hieracifolia** (L.), RAF.—Fireweed, (3), neglected clearings, (A.)
124. **Senecio aureus,** L.—Groundsel, Golden Rag-weed, Squaw-weed, (3), moist ground, (P.)
125. SENECIO VULGARIS, L.—Groundsel, (3), waste places, (A.)
126. CNICUS ARVENSIS (L.), HOFFM.—Canada Thistle, (1), cultivated soil, (P.)
127. **Cnicus lanceolatus** (L.), HOFFM.—Bull Thistle, Pasture Thistle, (1), grass land, (P.)
128. **Cnicus altissimus,** *var.* **discolor** (MUHL.), GRAY.—Common Thistle, (1), grass land, (P.)
129. **Cnicus odoratus** (MUHL.), B. S. P.—Pasture Thistle, (1), grass land, (P.)
130. ARCTIUM LAPPA, L.—Burdock, (1), neglected ground, (P.)
131. CICHORIUM INTYBUS, L.—Chicory, Succory, (2), neglected ground, (P.)
132. **Krigia amplexicaulis** (MICHX.), NUTT.—Dwarf Dandelion, (3), moist meadows, (P.)
133. **Hieracium scabrum,** MICHX.—Rough Hawk-weed, (3), shady places, (P.)
134. **Hieracium Canadense,** MICHX.—Canada Hawk-weed, (3), dry places, (P.)
135. TARAXACUM OFFICINALE, WEBER.—Dandelion, (2), grass land, (P.)
136. **Lactuca pulchella,** D. C.—Beautiful Wild Lettuce, (3), waste land, (P.)
137. **Lactuca Canadensis,** L.—Wild Lettuce, Trumpet Weed, Fire Weed, (2), neglected ground, (B.)
138. **Lactuca leucophæa** (WILLD.), GRAY.—Blue Lettuce, (2), neglected ground, (B.)
139. SONCHUS OLERACEUS, L.—Sow-thistle, (2), neglected ground, (A.)
140. SONCHUS ASPER, VILL.—Spiny-leaved Sow-thistle, (2), neglected ground, (A.)
141. SONCHUS ARVENSIS, L.—Field Sow-thistle, (2), waste places, (A.)
142. TRAGOPOGON PORRIFOLIUS, L.—Salsify, Oyster Plant, (3), cultivated land, (B. and P.)

LOBELIACEÆ, LOBELIA FAMILY.

143. **Lobelia syphilitica,** L.—Great Blue Lobelia, (3), moist places, (P.)
144 **Lobelia inflata,** L.—Indian Tobacco, (3), fields, (A.)

PLANTAGINACEÆ, PLANTAIN FAMILY.

145. **Plantago Rugellii,** DECNE.—Native Plantain, (3), waste places, (P.)
146. PLANTAGO MAJOR, L.—Common Plantain, White Man's Foot, (2), moist waste places, (P.)
147. PLANTAGO LANCEOLATA, L.—Rib-grass, Ripple-grass, English Plantain, Buck-horn, Buck, (1), grass land, (P.)

PRIMULACEÆ, PRIMROSE FAMILY.

148. ANAGALLIS ARVENSIS, L.—Common Pimpernel, Poor Man's Weather Glass, (3), waste places, (A.)

SCROPHULARIACEÆ, FIGWORT FAMILY.

149. VERBASCUM THAPSUS, L.—Mullein, (2), neglected land, (B.)
150. VERBASCUM BLATTARIA, L.—Moth Mullein, (2), neglected land, (B.)

151. VERBASCUM LYCHNITIS, L.—White Mullein, (3), waste places, (B.)
152. LINARIA VULGARIS, MILL.—Butter-and-Eggs, Ramsted, Toad-flax, (1), grass land, (P.)
153. **Linaria Canadensis** (L.), DUM.—Toad-flax, (3), dry soil, (A.)
154. **Scrophularia nodosa,** L.—Fig-wort, (3), moist places, (P.)
155. **Veronica serpyllifolia,** L.—Speedwell, (3), fields and roadsides, (P.)
156. **Veronica peregrina,** L.—Neck-weed, Purslane Speedwell, (2), neglected ground, (A.)
157. VERONICA ARVENSIS, L.—Corn Speedwell, (2), neglected ground, (A.)
158. **Pedicularis Canadensis,** L.—Louse-wort, (3), moist places, (P.)

VERBENACEÆ, VERVAIN FAMILY.

159. **Verbena hastata,** L.—Blue Vervain, (3), grass land, (P.)
160. **Verbena urticæfolia,** L.—Nettle-leaved Vervain, (3), grass land, (P.)

LABIATÆ, MINT FAMILY.

161. **Teucrium Canadense,** L.—Germander, Wood Sage, (3), moist places, (P.)
162. MENTHA PIPERITA, L.—Peppermint, (3), moist places, (P.)
163. MENTHA VIRIDIS, L.—Spearmint, (3), moist places, (P.)
164. **Mentha Canadensis,** L.—Wild Mint, (3), moist places, (P.)
165. **Lycopus sinuatus,** ELL.—Water Horehound, (3), moist places, (P.)
166. HEDEOMA PULEGIOIDES (L.), PERS.—Pennyroyal, (3), dry fields, (A.)
167. NEPETA CATARIA, L.—Catnip, (2), waste places, (P.)
168. NEPETA HEDERACEA (L.), B. S. P.—Ground Ivy, Gill, (3), waste places, (P.)
169. **Brunella vulgaris,** L.—Heal-all, Self-heal, Blue-curls, (3), grass land, (P.)
170. MARRUBIUM VULGARE, L.—Horehound, (3), waste places, (P.)
171. **Stachys aspera,** MICHX.—Hedge Nettle, (2), moist places, (P.)
172. LEONURUS CARDIACA, L.—Motherwort, (2), waste places, (P.)
173. LAMIUM AMPLEXICAULE, L.—Dead-nettle, Hen-bit, (2), waste places, (B.)
174. **Trichostema dichotomum,** L.—Bastard Pennyroyal, Blue-curls, (3), sandy fields, (A.)

BORRAGINACEÆ, BORAGE FAMILY.

175. ECHIUM VULGARE, L.—Viper's Bugloss, Blue-devils, Blue-weed, (1), waste ground, (B.)
176. LITHOSPERMUM ARVENSE, L.—Field Gromwell, Stone-weed, Wheat-thief, Pigeon-weed, (2), grain fields, (B.)
177. LITHOSPERMUM OFFICINALE, L.—Gromwell, Puccoon, (3), waste places, (P.)
178. **Echinospermum Redowskii,** *var.* **occidentalis,** WATSON.—Stick-seed, (3), waste ground, (B.)
179. ECHINOSPERMUM LAPPULA (L.), LEHM.—Narrow-leaved Stickseed, (2), waste ground, (B.)
180. **Echinospermum Virginianum** (L.), LEHM.—Stickseed, (2), waste places, (B.)
181. CYNOGLOSSUM OFFICINALE, L.—Hound's Tongue, (1), shady places, (B.)
182. SYMPHYTUM OFFICINALE, L.—Comfrey, (2), waste land, (P.)

CONVOLVULACEÆ, CONVOLVULUS FAMILY.

183. CONVOLVULUS ARVENSE, L.—Bindweed, (2), cultivated fields, (P.)
184. **Convolvulus sepium,** L.—Bracked Bindweed, Rutland Beauty, (1), neglected ground, (P.)
185. IPOMŒA PURPUREA (L.), LAM.—Morning Glory, (3), waste places, (A.)
186. **Ipomœa nil** (L.), PURSH.—Morning Glory, (3), waste places, (A.)
187. **Ipomœa pandurata** (L.), MEYER.—Man-of-the-earth, (2), cultivated fields, (P.)
188. CUSCUTA EPILINUM, WEIHE.—Flax Dodder, (3), on plants, (A.)
189. **Cuscuta Gronovii,** WILLD.—Dodder, (3), on plants, (A.)

SOLANACEÆ, NIGHTSHADE FAMILY.

190. SOLANUM DULCAMARA, L.—Bitter-sweet, (3), waste places, (P.)
191. SOLANUM NIGRUM, L.—Nightshade, (2), waste places, (A.)
192. **Solanum Carolinense,** L—Horse-nettle, (1), cultivated ground, (A.)
193. **Solanum rostratum,** DUN.—Beaked Horse-nettle, (1), cultivated ground, (A.)
194. **Physalis Virginiana** (MILL.), L.—Ground-cherry, (2), neglected land, (P.)
195. **Physalis pubescens,** L.—Hairy Ground-cherry, (3), neglected land, (A.)
196. LYCIUM VULGARE (AIT.), DUN.—Matrimony Vine, Box Thorn, Bastard Jasmine, (3), waste places, (P.)
197. DATURA STRAMONIUM, L.—Stramonium, Jamestown Weed, Jimson Weed, Thornapple, (1), neglected ground, (A.)
198. DATURA TATULA, L.—Purple Thornapple, (1), neglected ground, (A.)

APOCYNACEÆ, DOGBANE FAMILY.

199. **Apocynum androsæmifolium,** L.—Spreading Dogbane, (3), moist places, (P.)

ASCLEPEADACEÆ, MILKWEED FAMILY.

200. **Asclepias Syriaca,** L.—Milkweed, Silkweed, (1), neglected ground, (P.)
201. **Asclepias tuberosa,** L.—Butterfly-weed, Indian Posy, (3), neglected ground, (P.)

PHYTOLACCACEÆ, POKEWEED FAMILY.

202. **Phytolacca decandra,** L.—Pokeroot, Scoke, Garget, Pigeon Berry, (2), waste places, (A.)

CHENOPODIACEÆ, GOOSEFOOT FAMILY.

203. CHENOPODIUM ALBUM, L.—Lamb's Quarters, Goosefoot, Pigweed, (1), waste ground, (A.)
204. CHENOPODIUM URBICUM, L.—Pale Lamb's Quarters, Goosefoot, (2), waste places, (A.)
205. CHENOPODIUM HYBRIDUM, L.—Pigweed, Goosefoot, (2), waste ground, (A.)
206. CHENOPODIUM BOTRYS, L.—Jerusalem Oak, (2), waste places, (A.)
207. CHENOPODIUM AMBROSOIDES, L.—Mexican Tea, (2), waste places, (A.)
208. CHENOPODIUM AMBROSOIDES, *var.* ANTHELMINTICUM (L.), GRAY.—Wormseed, (2), waste places, (A.)

AMARANTACEÆ, AMARANTH FAMILY.

209. AMARANTUS CHLOROSTACHYS (WILLD.), L.—Common Pigweed Amaranth, (1), neglected ground, (A.)
210. AMARANTUS ALBUS, L.—Tumbleweed, Pigweed, (1), neglected ground, (A.)
211. AMARANTUS SPINOSUS, L.—Thorny Amaranth, (2), waste ground, (A.)
212. AMARANTUS PANICULATUS, L.—Branched Pigweed, (2), waste places, (A.)

POLYGONACEÆ, BUCKWHEAT FAMILY.

213. **Polygonum aviculare,** L.—Knot-grass, Door-weed, Goose-grass, (1), neglected ground, (A.)
214. **Polygonum erectum,** L.—Erect Knot-grass, (2), neglected ground, (A.)
215. POLYGONUM HYDROPIPER, L.—Smartweed, Water-pepper, (2), moist places, (A.)
216. POLYGONUM CONVOLVULUS, L.—Black Bindweed, (2), waste places, (A.)
217. **Polygonum tenue,** MICHX.—Slender Smartweed, (3), dry soil, (A.)
218. **Polygonum dumetorum,** *var.* **scandens** (L.), GRAY.—Climbling False Buckwheat, (2), neglected ground, (P.)
219. POLYGONUM PERSICARIA, L.—Lady's Thumb, Spotted Knotweed, (2), waste places, (A.)
220. **Polygonum Pennsylvanicum,** L.—Pennsylvania Smartweed, (3), moist places, (A.)
221. **Polygonum emersum** (MICHX.), BRITT.—Water Smartweed, (2), moist places, (P.)
222. FAGOPYRUM ESCULENTUM, MŒNCH.—Buckwheat, (3), neglected ground, (A.)
223. RUMUX CRISPUS, L.—Curled Dock, (1), moist places, (P.)
224. RUMEX ACETOSELLA, L.—Field or Sheep Sorrel, (1), poor soil, (P.)
225. RUMEX OBTUSIFOLIUS, L.—Bitter Dock, Broad-leaved Dock, (2), neglected land, (P.)

EUPHORBIACEÆ, SPURGE FAMILY.

226. **Euphorbia maculata,** L.—Milk Purslane, Spotted Spurge, (2), neglected ground, (A.)
227. **Euphorbia hypericifolia,** L.—Hypericum Spurge, (2), neglected ground, (A.)
228. **Euphorbia corollata,** L.—Showy Spurge, (2), neglected ground, (A.)
229. EUPHORBIA CYPARISSIAS, L.—Cypress Spurge, (3), neglected ground, (A.)
230. **Acalypha Virginica,** L.—Three-seeded Mercury, (2), moist places, (P.)

URTICACEÆ, NETTLE FAMILY.

231. **Urtica gracilis,** AIT.—Slender Nettle, (3), moist places, (P.)
232. URTICA DIOICA, L.—Stinging Nettle, (2), waste ground, (P.)
233. CANNABIS SATIVA, L.—Hemp, (3), waste places, (A.)

ARACEÆ, ARUM FAMILY.

234. **Symplocarpus foetidus** (L.), SALISB.—Skunk Cabbage, (3), low grass land, (P.)

LILACEÆ. LILY FAMILY.

235. **Smilax rotundifolia**, L.—Greenbriar, Cat Briar, (2), low grass land, (P.)
236. ASPARAGUS OFFICINALE, L.—Asparagus, (3), neglected ground, (P.)
237. **Allium Canadense**, KALM:—Wild Garlic, (3), moist places, (P.)
238. ALLIUM VINEALE, L.—Wild Onion, Garlic, (1), fields and grass land, (A. and B.)
239. **Allium tricoccum**, AIT.—Wild Leek, (1), rich low land, (A. and B.)

JUNCACEÆ, RUSH FAMILY.

240. **Juncus marginatus**, ROEBT.—Common Rush, (3), low grounds, (P.)
241. **Juncus tenuis**, WILLD.—Slender Rush, (3), low grounds, (P.)

COMMELYNACEÆ, SPIDER-WORT FAMILY.

242. **Tradescantia Virginica**, L.—Spider Wort, (3), waste places, (P.)

CYPERACEÆ, SEDGE FAMILY.

243. **Cyperus esculentus**, L.—Sedge, Galingale, (1), low cultivated fields, (P.)
244. **Cyperus strigosus**, L.—Bristly Galingale, (2), grass land, (P.)
245. **Cyperus rotundus**, L.—Nut-grass, Coco-grass, (1), cultivated ground, (P.)

GRAMINEÆ, GRASS FAMILY.

246. ELEUSINE INDICA (L.), GÆRT.—Crab-grass, Yard-grass, Dog's Tail, Wire-grass, (2), neglected ground, (A.)
247. ERAGROSTIS MAJOR, HOST.—Stinking-grass, (2), neglected ground, (A.)
248. CYNODON DACTYLON (L.), PERS.—Bermuda-grass, Scutch-grass, (1), cultivated ground, (P.)
249. BROMUS SECALINUS, L.—Chess, Cheat, (1), grain fields, (A.)
250. BROMUS RACEMOSUS, L.—Chess, Cheat, (1), fields, (A.)
251. BROMUS TECTORUM, L.—Slender Chess, (2), dry fields, (A.)
252. AGROPYRUM REPENS (L.), BEAUV.—Couch, Quick or Quack-grass, (1), neglected ground, (P.)
253. HORDEUM JUBATUM, L.—Squirrel-tail Grass, (2), neglected ground, (B.)
254. PANICUM GLABRUM (SCH.), GAUD.—Smooth Panic-grass, (3), waste places, (A.)
255. PANICUM SANGUINALE, L.—Crab or Finger-grass, (2), neglected ground, (A.)
256. **Panicum capillare**, L.—Old Witch Grass, (3), neglected ground, (A.)
257. **Panicum dichotomum**, L.—Panic-grass, (3), neglected ground, (P.)
258. PANICUM CRUS-GALLI, L.—Barnyard Grass, Cock's Foot, (3), waste places, (A.)
259. SETARIA GLAUCA (L.), BEAUV.—Pigeon-grass, Summer Foxtail, Puss-grass, (1), neglected grounds, (A.)
260. SETARIA VIRIDIS (L.), BEAUV.—Green Foxtail, Bottle-grass, (1), neglected grounds, (A.)
261. SETARIA VERTICILLATA, BEAUV.—Whorled Foxtail, (2), neglected ground, (A.)
262. **Cenchrus tribuloides**, L.—Hedge-hog, Bur-grass or Bear-grass, (1), neglected ground, (A.)

263. **Pteris aquilina,** L.—Brake, Braken, (3), grass land, (P.)
264. **Onoclea sensibilis,** L.—Sensitive Fern, (3), grass land, (P.)

EQUISETACEÆ, HORSETAIL FAMILY.

265. **Equisetum arvense,** L.—Common Horsetail, Scouring Rush, (3), sandy soil, (P.)

The distribution of the 265 species as to the length of life is as follows: Annuals, 105; biennials, 34, and perennials, 126, or nearly as 3 : 1 : 4, respectively.

If arranged according to the somewhat arbitrary scale of worst, bad and indifferent weeds, the figures would be 54, 98 and 113. The 54 worst weeds are distributed as follows as to their term of life: Annuals, 30; biennials, 7, and perennials, 17. This shows that more than half of the most troublesome plant pests are annuals. The second class of weeds includes those which interfere less with tillage and crop-growing, and are arranged as follows: Annuals, 44; biennials, 15, and perennials, 39.

The third group of weeds has 31 annuals, 12 biennials and 70 perennials.

The following table may be arranged for the more effective presentation of the subject:

	Annuals.	Biennials.	Perennials.	Total.
Worst weeds	30	7	17	54
Bad weeds	44	15	39	98
Indifferent weeds	31	12	70	113
Total	105	34	126	265

It will be seen that in passing from the worst weeds through the middle class to those which are termed indifferent, the percentage of perennials increases rapidly.

Figures, however, do not show everything. A single species, for example, may make more trouble on the farm than several others in the same class, but the above table could not show this. The ten native annuals of the worst groups far excel, in work of destruction, the ten perennials of the same class. Note the array of pests the first vile set includes: daisy fleabane, great ragweed, Roman ragweed, cockle bur or clot bur, beggarsticks or bur marigold, sometimes called tickseeds and pitchforks, horse nettle, beaked horse nettle,

prostrate amaranth or pigweed, knot grass and the detestable bur grass. Against these the native perennials make a feeble array, among the worst of the ten being the quack grass and the bull or pasture thistle.

This report is only offered as a preliminary to the more thorough study of the subject. Remedies will depend upon the circumstances which surround each case. Only a general prescription is offered. All annuals need to have perfect seed for the continuation of the species. To keep all such from "going to seed" is certainly a most effective remedy for the weed-sick land. The biennials are only few in kinds, and they, at most, live only two years. Keep these from seeding by hoeing or mowing or some similar process. With the perennials the plan should be different. These pests take a firm hold upon the soil and need to be uprooted and burned or otherwise destroyed. They are frequently very tenacious of life, but if kept from maturing seed and storing up nourishment for future growth, they, in time, will be overcome. The leaves are the factories for food evaporation, and if these are removed the stoutest weed will ultimately die.

The best time to kill a weed of any class or nationality is while it is young. A mustard seed may lie dormant deep in the soil for many years, but when the plow has brought it near the surface, the sun and rain having quickened its life, there only remains two courses to pursue—either to live and grow, or die from lack of favoring conditions. Early culture is therefore the easiest, quickest and most profitable method of weed-killing. When this is pursued the soil at the same time receives the treatment most advantageous to the crop then growing and the ones that are to follow.

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BRIEF DESCRIPTIONS OF THE WEEDS OF THE ENGRAVINGS.

Twenty-four of the leading kinds of weeds of the United States are presented in the succeeding full-page plates. These engravings have appeared, a few at a time, in the report of the Government Botanist, Dr. George Vasey, as found in the annual volume of the Department of Agriculture, and to whose courtesy is due the privilege of bringing them together here for the benefit of the New Jersey crop-growers. The species have been arranged in the same order as they appear in the weed list, and the first to which attention is called is the charlock.

PLATE I.

BRASSICA ARVENSIS (L.), B. S. P.

(Charlock, or Yellow Mustard.)

Brassica arvensis is a coarse, branching, annual weed, often three feet high, and particularly injurious in grain fields, choking out the plants that should occupy the soil. The seeds retain their vitality, and this makes it difficult to clear a field of the pest when once the soil contains a large number of the seeds. It, of course, follows that all charlock plants should be destroyed before they pass the period of full bloom.

PLATE II.

CAPSELLA BURSA-PASTORIS (L.), Mœnch.

(**Shepherd's Purse.**)

Capsella Bursa-pastoris is a very common, low-branching annual, that quickly takes possession of neglected ground in early summer, and produces a vast number of seeds in the little purse-shaped pods. Like the purslane, this weed, while capable of overriding the young crops, is quickly subdued by the frequent passage of the cultivator. Neither root deeply, but both should be kept from maturing their seed.

PLATE III.

Hypericum perforatum, L.

(St. John's-Wort.)

Hypericum perforatum is a somewhat showy perennial weed, from Europe, that is often very troublesome in grass land. The upright habit of the plant, and the shape and size of the bright yellow flowers, are well shown here. This weed needs to be kept from going to seed by early cutting, and, in permanent pasture or meadow, pulling out by the roots, when the soil is moist, is still better.

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PLATE IV.

Lychnis Githago (L.), Lam.

(Cockle, or Corn Cockle.)

Lychnis Githago is a weed of the wheat field, and is, when in bloom, one of the most showy of the plant pests. It is an annual, from Europe, tall in habit, with large pink flowers. The seeds are difficult to screen from the wheat, and therefore the cockle has become introduced into nearly all wheat regions with the seed grain. The leading point in eradication is to pull the cockle from the field before it goes to seed, and use only seed grain that is free from the cockle.

6 5

PLATE VII.

Daucus Carota, L.

(Wild Carrot.)

Daucus Carota is one of the best known and most dreaded of the weeds of New Jersey, and scarcely needs any engraving here to make anyone better acquainted with it. The small flowers are brought into a cup-shaped cluster, which finally becomes a mass of fruit. Unlike most of the weeds here treated, the carrot lives for two years. During the first season the plant consists of a rosette of leaves close to the ground and the strong root system below the surface. The second year is employed in shooting a long flower-stalk, and the production of the numerous seeds, armed with minute hooks.

PLATE VIII.

AMBROSIA ARTEMISIÆFOLIA, L.

(Ragweed, Roman Wormwood.)

Ambrosia artemisiæfolia is a common, coarse, annual weed, native to many parts of the country, only a small portion of the top of which is shown in the engraving. It is particularly a stubble weed, and creeps quickly into any neglected or unoccupied spot in grass land, cornfield or garden, and flourishes along the roadside. Prevent seeding by early cutting, where the hoe and cultivator do not reach the young plants.

PLATE IX.

XANTHIUM CANADENSE, Mill.

(Cockle Bur, Clot Bur.)

Xanthium Canadense is a most miserable, stout annual weed, a small portion of a single branch of which is here shown. The variety *echinatum* is the form found throughout the State, especially in sandy soil and along water-courses. The plant is so large and the burs so disagreeable to live stock, that there is very little excuse for letting it go to seed. Look after the waste land as well as the cultivated fields, or else these pests will perpetuate themselves in out-of-the-way places.

PLATE X.

BIDENS FRONDOSA, L.

(Beggar's-ticks, Bur Marigold.)

Bidens frondosa is one of the few bad weeds that are native to our own country, and it quickly establishes itself in field or garden. While inoffensive in general appearance, as indicated by the engraving, it is, on account of its awned fruits, most disagreeable, as they fasten into any person's clothing or the hair and wool of passing live stock; and the seeds thereby become widely disseminated. It is an annual, and demands the ordinary methods for its eradication.

L.R.Stowell del.

PLATE XI.

ANTHEMIS COTULA, L.

(Mayweed, Dog-fennel.)

Anthemis Cotula is a foreign, annual weed, that has become thoroughly at home in all parts of the State, and particularly along roadsides, around barn-yards, and many other places where grass does not keep it out. A spray of the strong-scented herb is shown here.

PLATE XIII.

CNICUS ARVENSIS (L.), Hoffm.

(Canada Thistle)

Cnicus arvensis, when abundant, is perhaps the worst of all weeds, because difficult to destroy, and most disagreeable to both man and beast, on account of its piercing prickers. It is a perennial, and its root stocks take a firm hold upon the soil and propagate the pest rapidly below ground. Many methods have been tried for the killing of these thistles, and perhaps there is none better than cutting them before flowering, plowing the ground, growing a crop of Hungarian, which is either cut for hay or plowed under, followed by winter rye, which is also treated as the Hungarian, and the land put into hoed crops for two or more years. The engraving shows flower clusters, leaf, root stock, and enlarged flower of the Canada thistle.

A. STOWELL. DEL.

PLATE XV.

SONCHUS OLERACEUS, L.

(Sow Thistle.)

Sonchus oleraceus is a tall, somewhat succulent annual, belonging in the same family with the burdock, daisy, mayweed and ragweed, as a glance at the plate will indicate. While not as aggressive as some of the above, it sometimes becomes a decided pest in cultivated land and demands similar treatment.

PLATE XVI.

ECHIUM VULGARE, L.

(Bugloss, Viper's Bugloss.)

Echium vulgare is a coarse, hairy, biennial foreign weed, that is rapidly becoming abundant in many parts of the State. The flowers are large and numerous, of a deep blue, and handsome. The engraving shows the root, stem, leaf and branch of this pest. It can be pulled when the soil is moist.

PLATE XVII.

Convolvulus sepium, L.

(**Bindweed.**)

Convolvulus sepium, as the common name suggests, is a twining plant, and thereby often entangles and chokes out the field crops. The flowers are large, as well shown in the plate, and resemble those of the morning-glory. Being a perennial, and deep rooted, it is not to be easily eradicated at once, but, by persistent removal of the leafy vines, the weed is weakened, and finally dies.

PLATE XVIII.

Solanum Carolinense, L.

(Horse-nettle.)

Solanum Carolinense is another perennial weed, with weak, prickly stems, but with a firm grasp upon life, and therefore not easy to root out and destroy. A portion of a stem, with blossoms and a fruit cluster, are shown in the plate. It is a native of this country, and particularly pernicious in the South.

PLATE XIX.

DATURA STRAMONIUM, L.

(Jimson Weed, Stramonium.)

Datura Stramonium is one of the rankest growing of all annual weeds, attaining six feet in height, with a spread of as many feet, in a few weeks. It has come to us from Asia, and is widespread in our country. A single tip of a branch is shown in the plate, with a capsule and the mature seeds. Taken in time, there is no great difficulty in keeping the land clean of this tropical plant.

PLATE XX.

ASCLEPIAS SYRIACA, L.

(Milkweed.)

Asclepias Syriaca is a perennial, native, coarse weed, thick leaves, borne upon straight stems, pervaded with a ı The peculiar structure of the flowers and the manner in are borne, are shown in the plate. The seeds are tufted silky hairs, which serve to scatter them by the winds. penetrate deeply into the soil, and are not easily removed the land that is badly infested with this pest, under culture way to eradicate it. No plants should be permitted to pı

PLATE XXI.

CHENOPODIUM ALBUM, L.

(Lamb's Quarters, Pigweed.)

Chenopodium album is a coarse, foreign, annual weed, extensively naturalized in many parts of the United States. The engraving shows only a small branch of a plant and the small clusters of inconspicuous flowers. It infests neglected cultivated ground, and should be prevented from going to seed.

PLATE XXII.

RUMEX CRISPUS, L.

(Dock.)

Rumex crispus is a European perennial weed, deep rooted, and coarse in stem and leaf. The engraving shows a single leaf and a spray of the fruit. It is particularly bad in grass land, and thrives in neglected lanes and roadsides and along small water-courses. The large roots can be pulled, using a small spade. No seed should be allowed to form.

PLATE XXIII.

Rumex Acetosella, L.

(Sorrel.)

Rumex Acetosella is a much smaller plant than its relative just mentioned, but, like it, is a perennial, naturalized from Europe. It is particularly abundant upon poor soil, but will grow all the better upon rich earth. The prevailing method of forming plants from underground stems is abundantly illustrated in the plate. This pest can be subdued by keeping the infested land under the plow for a short time.

PLATE XXIV.

SETARIA VIRIDIS (L.), Beauv.

(**Foxtail, Puss-grass.**)

Setaria viridis is quite a nuisance in many fields, and particularly stubble ground. It is an annual that has become thoroughly introduced from Europe. The engraving shows the various parts of this grass.

REPORT OF THE ENTOMOLOGIST.

REPORT OF THE ENTOMOLOGIST.

BY JOHN B. SMITH.

NOTES OF THE YEAR.

The experience gained during the summer of 1889 and during the autumn and winter of the same year, while addressing farmers' clubs and county boards of agriculture, led me to believe that the most injurious insects were the squash and melon borer, the plant lice on the same crops—which were seriously complained of—the cabbage maggot, the rosebug, and the wire worms and cut worms on corn. My plans were made to secure the co-operation of farmers in special lines, and to send them for trial such substances as I considered most likely to reach the insects complained of. It was my intention to experiment systematically with the various insecticide substances recommended, and the liberality of manufacturers in almost every case provided me with an abundance of material.

A circular setting forth the proposed lines of work, and containing a request for co-operation on the part of farmers, was issued early in the year, and sent to all the newspapers in the State, and to the leading papers in New York and Philadelphia. It was generally reprinted, and, in condensed form, was republished as an associated press dispatch all over the country. The response was not what I expected, and I found an unforeseen difficulty in securing opportunities for experiment. It was not until the insects appeared and the crops showed injury, that growers would write me, and then it was too late. I did, however, receive some replies, and Bulletin 75 of the Station shows at length what experiments were made. The results attained are peculiarly valuable from the fact that the trials were made under ordinary field conditions, by practical farmers, and may be taken as a fair record of what a given substance will do. As, however, many conditions might influence a result unduly, either favorably or unfavorably, and its bearing be not noted by the farmer, a series of check

experiments were made by myself, looking principally to the killing power of the substances tried. These experiments were carried on all during the summer, and the results are noted briefly in the following pages.

The greater part of the season of 1889 was devoted to the study of cranberry insects, and my only work on these pests during the present year, was to put into practice some of the recommendations made in Bulletin F, which contains the results of my studies. With this view, some experiments were carried on under my direction on the Buckalew bogs, near Jamesburg, which are recorded in the following pages. There are also some additional notes on the species most injurious during the present year.

The practice of spraying fruit trees continues to extend, and is attended with uniformly good results. The short crop of fruit caused by the unfavorable climatic conditions, made the curculio injuries unpleasantly conspicuous, and a few notes on that pest are added.

The rose-chafer had proved so serious a pest to grape-growers in South Jersey, that I made a trip into the Vineland region in May, again in June, and another in October, to make personal observations and experiments. Opportunity for this was afforded by Col. A. W. Pearson, to whom I owe thanks for assistance, and for unlimited facilities.

While in that region, complaint was made of the insects infesting sweet potatoes, and as this crop is an important one, I made such observations and studies as were necessary, and the results are incorporated in this report.

Very early in spring, complaints of an *Aphis* or louse attacking wheat came from South and West Jersey, and the pest rapidly extended to the latitude of New Brunswick, no reports of damage coming from northern points. The rye was also attacked and badly injured, and then the oats showed signs of a sickness, which was universally attributed to the louse, but which on investigation proved to be probably due to an attack of a nematode worm at the roots. These pests were all studied and reported upon.

Plant lice were unusually abundant throughout the summer, and Bulletin 72 of the Station treats of those most common and injurious. Of these the peach aphis has been very abundant and destructive.

Considerable alarm was occasioned by an irruption of the clover-leaf beetle larvæ, which, for a few days, threatened that crop with

total destruction. Fortunately, a fungus attacked the larvæ before maturity and carried them off completely. I did not even succeed in carrying a single specimen to the pupa state.

The correspondence has been heavy, over six hundred letters having been written during the year, many of them taking considerable time in preparation, and it has been largely crowded into a few weeks.

I have continued my attendance at the meetings of the Entomological Society, at Newark, and less regularly at the New York and Philadelphia Societies, and from the members have secured many specimens for the collection.

This, the museum branch of the Department, has received considerable attention; but the work has been largely confined to the accumulation of material, there being no sufficient number of boxes for its display until late in the year. Now, however, cabinets and boxes are at hand, and I hope, during the ensuing winter, to get a large part of the collections into good shape.

It is with gratification that I am able to report a continual spread of interest among farmers in my work at the Station, and an increase of confidence in the recommendations made. There is a more general disposition to ask for information regarding troublesome insects, and a greater readiness to adopt suggestions. The addresses at county board meetings bring the work of the Station prominently before the farmers and enable them to ask just those questions that are of most interest to them. They are of value to the Entomologist, since they give him the opportunity to discover what kinds of insects are most needing investigation, and enable him to gather the practical experience of farmers—often of the utmost value.

I have found my work advanced by this close intercourse with the farmers, and I believe I can thus much better judge of what will meet with general favor.

Finally, I have found that it answers very much better to present to the farmers the philosophy of entomology, as well as the facts. I have found the average New Jersey farmer ready to understand the facts upon which theories are based, and ready to understand the theories deduced from the facts. I have had no hesitation, therefore, in presenting such details of anatomical structure as I considered desirable, to explain the philosophy of dealing with the particular species treated of.

In Bulletin 75 of the Station this subject was treated of at some length, and the experiments made during the year were given in some detail. The experiments themselves need not be repeated here, but the conclusions reached, form legitimately a part of this report.

Insecticides, and all remedies against insect attack, should be as carefully selected as remedies against disease. No one insecticide can be used under all circumstances nor against all species. Any material for which this is claimed may be at once set down as a fraud, and should be treated as such until its real range of action is realized.

For a large proportion of insects which feed upon the substance of the plant, devouring the leaves, we have a perfect remedy in the arsenites. These can be used whenever the insects feed exposed upon or devour the entire substance of the leaf, provided that this leaf itself is not to be eaten by man or beast.

Contact poisons must be used against such species as do not eat the substance of the leaf itself but merely suck the sap, as do the plant lice, and also against such species as eat the substance of leaves which are used as food for man or beast.

Of contact poisons, some have an entirely different range of effectiveness from others. Some are penetrating, like kerosene, others act only on actual solution on the body of the insect, like tobacco; some have a corrosive effect, like lime. Each case must be considered on its own merits. For borers, the mode of proceeding must be specially adapted to either prevention or destruction. Underground insects must also be particularly treated, so that the farmer's battery must include materials and methods for all classes of pests.

Not all kinds of insects are easily reached in their most injurious state—*e. g.* many borers—and the life history of species must be known in order to judge of the best time to go at them.

In a general way, an insect has four more or less distinct stages: the egg, the larva, the pupa and the imago or perfect insect.

The *egg* stage is a quiescent one in which no damage is done by insects. Many pass the winter in this stage, and sometimes we can attack them in this condition, as when the eggs are laid on stubble

The *larva* stage is always an active one, whether as caterpillar, grub, maggot, slug or "worm." No insect larva, however, is a true worm, the term having come into use from the resemblance some caterpillars are supposed to have in general appearance to real worms. It is in this stage that insects usually do their injury, and in this stage they are most usually attacked by insecticides where they feed in such position as to enable them to be so reached.

The *pupa* stage is, in many cases, a quiet one, in which the insect prepares for the final transformation into a butterfly, moth, beetle, fly or bee; but in the case of grasshoppers or true bugs, to which latter the plant lice belong; the pupa is active and feeds right along; the only change undergone by these insects is the addition of wings. In many cases the insects winter in this stage, remaining quiescent, ready to emerge as perfect insects or imagos on the approach of summer.

In this stage we can often reach them very effectively. Many transform in or on the plants infested by them in the larva state, and by gathering and burning these we prevent the maturing of the species. Others remain in the ground during the winter, in oval cells formed by the larvæ. These we can reach and destroy by fall plowing, exposing them to direct contact with the cold and wet. They are also brought thus within the reach of birds and mice, which will not miss the opportunity.

The final or imago stage of an insect is when it has become a fly, butterfly, beetle or bee, or, in the case of grasshoppers and bugs, when they have become winged.

In this stage, flies, butterflies and bees cease to be injurious. Beetles, grasshoppers and bugs keep right on, and are often worse than their larvæ. The rose-chafer is a case in point. The larva feeds sparingly on roots of trees and grasses, and is not noticed except by accident. The beetle, on the contrary, is among our most destructive pests. The insects emerge from the ground in immense numbers, nearly at the same time, and invade vineyards, orchards and gardens.

Insects of this nature must be fought in the mature state. We must not only get some means of destruction, but some means of destruction more rapid in action than the arsenites or other internal poisons.

Sometimes, when the insects seem beyond easy reach in all stages, we can use preventive measures, which are often very satisfactory, forcing the insects to other breeding-places. In making out a plan

this, the Entomologist makes all his studies of the life history of insects.

It is not enough that the proper insecticide be selected and used, it must also be properly applied. This is a matter of much more importance than farmers are generally prepared to believe. Poisons are often put on wastefully, unnecessarily strong, thick in one place, none at all in another. This is often mere waste of money and time, besides having the disadvantage of creating a distrust of insecticide applications. The rule should be, put it on as thinly and evenly as possible; cover all parts of the plant, and cover as thinly as may be. Most insects need but a mere trifle of poison to be killed.

In Bulletin 75 I have gone into this matter in some detail, and this should be consulted on the subject of pumps and nozzles.

The range of the more important poisons will be here given, the experiments made being already recorded.

THE ARSENITES.

These are London purple and Paris green. They are both generally used in water, and are effective at the rate of one pound to 200 gallons. For some insects one pound to 300 gallons is sufficient, but the stronger mixture is the more reliable. Paris green contains no soluble arsenic, is heavy, and does not suspend well in water. It is usually but very slightly injurious to foliage when not used in abnormal quantities, and it is the favorite arsenite in New Jersey.

London purple contains some soluble arsenious acid, which in turn dissolves the arsenite of lime when not very dilute, and this is very injurious to foliage. This has made the poison disliked among our farmers. It is lighter than Paris green, much more finely divided, and remains in suspension much better. It would therefore be the better substance to apply, could the burning effect be mitigated, and this, Mr. C. P. Gillette, of the Iowa Station, proves can be done by adding milk of lime. It was too late for me to try this practically; but laboratory experiments prove that the addition of lime renders all the arsenic in London purple insoluble. The delicate copper test showed not a trace of arsenical deposit, while on the check lot, to which no lime was added, the deposit was obvious at once. This makes the purple safe to use on even peach trees, at the rate of one

pound in 250 gallons of water, if two pails of milk of lime be added. For other plants it can be used of the same strength as Paris green, adding always two pails of milk of lime to the pound of London purple.

Few persons now use the dry applications of arsenites with plaster; but where, for any reason, this is desirable, lime is the better substance to mix with; or bicarbonate of lime, a sedimentary powder, may be used to better advantage than plaster.

POTASH SALTS.

Potash has been heretofore known only as a fertilizer of very high grade. Experiments made by me during the past year, prove that it has a high value as an insecticide as well. It is effective against plant lice of all kinds, against many naked larvæ, and against the wire worms (*Iulus*) on potatoes. It also kills cabbage maggots. Though I have tested it principally on over-ground insects, yet its greatest field of usefulness is against those pests that live in the ground or about the roots of plants. In localities in which corn is infested by cut worms, wire worms, etc., a heavy dressing of potash before planting will destroy almost all insects in the ground at that time. For the corn-root louse, I have no doubt this will prove a perfect remedy. Where potato ground is infested with the wire worm (*Iulus*), a heavy dressing with kainit will bring relief. Peach orchards that are infested with the black peach aphis on the roots, can be renovated by the use of this same substance. On bringing the matter to the attention of farmers, many have been able to recollect that with the use of potash certain insect troubles ceased; but they had not theretofore credited the potash with that result. This item is especially commended to peach-growers in South Jersey. The kainit is preferable to the muriate as an insecticide.

TOBACCO.

This substance in the form of a fine dust is quite effective against plant lice and a variety of smooth, naked insects. It is more effective, however, as a decoction, using one pound of tobacco to one gallon of water. The tobacco is best ground, or at least cut into small chips,

and it should be then steeped in two quarts of boiling water; afterward cold water to make up the gallon can be added.

This decoction is excellent for most garden pests, including plant lice, and it is almost a specific against flea beetles on potatoes and other plants. The range of tobacco as an insecticide is by no means settled, and I believe it will obtain a wider range than any yet indicated.

LIME.

Lime as an insecticide is old, but curiously enough no one has ascertained exactly what it will do. It has been recommended frequently for a variety of purposes, and evidence as to its value is very conflicting. A great deal of this discrepancy arises from the fact that the lime is not always used in the best condition. As an insecticide it should be fresh and sifted, the finer the better. Air-slaked lime is generally used and is good. Still better is the dry hydrate. This is made by adding to the lime just water enough to slake, and then sifting. Shell lime and stone lime seem equally valuable. From such evidence as I have been able to gather, this seems the most effective remedy against cabbage worms. Col. Pearson has used it successfully, and several others, farmers, have informed me that they had no trouble in keeping their cabbages clear by dusting with *fresh* lime whenever necessary during the season. It should be applied in the morning while yet the plants are moist. It has been used successfully against the larva of the asparagus beetle and against other naked larvæ. Potatoes can be cleared of the young larvæ of the potato beetle by its use. It has been recommended as a repellant in some cases, not always on sufficient grounds. Some claim that the rose-chafer can be driven off by its use, but I have had no success in that respect. Further suggestions will appear in other parts of the report.

WHITE HELLEBORE.

This substance retains its favor as an insecticide for currant worms, grape slugs, and other saw-fly larvæ, and it exercises what may be considered a specific effect on them. It can be used dry but is just as effective and goes further used as a decoction, one ounce to one gallon of water.

Pour one quart of boiling water through a bag containing the

powder, turn the powder into the extract, let it steep for a while and add cold water to make the gallon; then spray with a fine rose nozzle. Some recommend a mixture as weak as one ounce to three gallons of water, but I should scarcely deem this reliable unless the plants were thoroughly drenched, and then nothing would be saved after all.

NAPTHALINE.

This substance has been sometimes mentioned as an insecticide, and some use has been made of it against the phylloxera. It is, however, practically unknown as a useful substance for general employment, and its killing power has not been tested. I have made some experiments with this substance the present year which have been unsuccessful in their practical application, but prove that there may be a large range of usefulness for it if once the best method of application is ascertained.

For details of experiments made, Bulletin 75 must be referred to.

PYRETHRUM.

Pyrethrum, known as Persian or Dalmatian insect powder, or "Buhach," when grown in California, is one of the most effective of our contact powders. In its pure state it is quickly fatal to almost all naked, soft-bodied insects, but seems ineffective against hairy larvæ and against beetles and bugs. Most beetles will be stupefied for a time; but it is rather an intoxication than any real paralysis, and sun and air quickly effect a recovery. Applied dry, it is almost equally effective when mixed with five or six times its bulk of flour, allowing the mixture to stand tightly closed for a few hours before using.

The insecticide property seems to consist of a volatile matter soluble in water, and a water mixture is even more effective than the dry powder. Cold water seems to act as well as hot in extracting the insecticide properties, but the limit of effectiveness, diluted, varies as against different species. Against cabbage worms, one ounce to two gallons of water has been found effective; against chrysanthemum aphids, one ounce to one gallon was utterly ineffective.

One objection to its use is the expense. It is very dear compared to other insecticides, and there is scarcely a field for its use that is not covered by some cheaper and equally effective substance.

It has, however, one very great advantage, and that is its entire harmlessness to man or beast. For use on animals it is excellent, and though it will not kill fleas it will drive them off, and seems fatal to bird and poultry lice. In the household it will conquer most of the insect nuisances, and for use on house plants it is unexcelled, except in the case of scale insects.

Mixed with powdered napthaline, its efficiency is very decidedly increased, and this mixture is on the market as an "Insect and Moth Exterminator."

No general rule concerning its use will be given, but, wherever recommended, the necessary proportions and directions will be added.

KEROSENE.

Except the arsenites, there is no more effective insecticide than kerosene. Its range of usefulness is greater than that of any other, and only the trouble of preparing it seems to prevent its universal use. Kerosene is fatal to all insects when applied pure, but is almost equally fatal to plant-life, and hence it must be diluted to such an extent as to make it available as an insecticide without also injuring plant-life. It is not miscible with water directly, but can be emulsified or combined with soap or milk so as to mix in that form to any extent. The formula for the soap mixture, which I consider much the best, is:

Kerosene	2 gallons.
Water	1 gallon.
Soap	half pound.

Make a suds of the soap and water, and pour boiling hot into the kerosene. Churn with a force-pump for ten minutes or until it forms a thick cream.

This emulsion will keep for months if well made and kept in a cool place, and can be mixed with water as required. A common hard soap should be used, or if green, a little more may be added.

The proportion in which the emulsion should be used, varies somewhat. Against scale insects one part in ten of water is effective, and usually one part in twelve, well applied, will do. This latter mixture will kill almost all unprotected insects, and one part in fifteen is

sufficient for most plant lice. It has a great addition to its range of usefulness, in being of service against many underground forms, such as cabbage maggots and the like.

For details of experiments, Bulletin 75 should be referred to.

FISH-OIL SOAP.

A good formula for making this is as follows:

Hirsch's crystal potash lye	1 pound.
Fish oil	3 pints.
Soft water	3 gallons.

Dissolve the lye in the water, and when brought to a boil, add the oil. It should boil about two hours, and when done, can be filled up to make up the loss by evaporation. When cold it can be cut into cakes.

Where the trouble of making is considered too great, the ordinary whale-oil soap of commerce may be substituted; but it is not so good and costs more.

Against most aphides this soap is effective at the rate of one pound to eight gallons of water. It is the cheapest application against plant lice, and as effective as any. With a knapsack sprayer like the "Eureka" or the "Galloway," and a barrel of this fish-oil soapsuds, there should be no trouble in keeping a cabbage-field, for instance, clear of all aphides. Melon and cucumber vines could be protected in the same way.

Against scale insects it should be used double strength, and even then is not so effective as the kerosene emulsion.

It has been used to good effect, made very strong, say one pound to two gallons, and left standing for a few days to make a jelly-like mass, and then put on with a brush on fruit trees as a protection against borers. Half pint of crude carbolic acid added to the suds while jellying, adds to the effect. Thoroughly spraying the trunk twice a week with the ordinary mixture has proved effective in preserving quinces from the attacks of the borer.

Gas-tar and tar-water have proved utterly ineffective in my experience, and I find no place for them among insecticides.

Bulletin 75, above cited, contains in more detail the range for all

of the above insecticides, and also a record of such experiments as have been made. A few proprietary mixtures or preparations are noted where they seemed meritorious, but we need here only refer to the composition of such as are on the general market.

Hammond's Slug Shot is London purple, plaster and perhaps some Paris green.

Peroxide of silicates is Paris green and plaster.

Poole's insect powder is Paris green and finely sifted coal ashes.

All of these are advertised as "harmless," and indeed practically the danger is very small; but the statement is misleading, for no arsenical mixture is "harmless."

"*X. O. Dust*" is a tobacco and carbolic acid compound, and is a meritorious substance.

"*Nicotinia*" is a rather finely ground tobacco, which is useful for many purposes.

"Eureka Insecticide" is a sulphur mixture effective against the "red spider," but not of much use otherwise.

"Sunderline's Insecticide" is bicarbonate of lime, sold at many times its real value.

After all this record, it may appear like a hopeless task for the farmer to supply himself with all the articles needed for warfare against insects, but the case is not really so bad.

For machinery, if orchard work is to be done, a tank on wheels with a good force-pump is desirable; where potatoes are also cultivated, an attachment by which the pump is geared to the axle is desirable, and an arrangement of nozzles so that, by simply driving through the potato field, several rows are automatically sprayed at the same time. The Nixon Nozzle and Machine Co., Dayton, Ohio, make, by all odds, the best machines for this purpose; but like all good things, they are not cheap. This machine can be used equally well for all field crops, either geared or as a hand-pump.

Where vineyards or gardens are to be protected, or small fruits are raised, a knapsack sprayer is almost indispensable. With this a man can go anywhere, and, with a "Vermorel" or "Cyclone" nozzle, four or five gallons will cover a very large space, so that refilling is not so often necessary. For the cabbage-field nothing is as good, and, indeed, for all except orchard work, one of these knapsack sprayers is the most useful machine available.

The "Eureka" sprayer is made by Adam Weaber, Vineland, N. J.

The "Galloway" sprayer is made by Albinson & Trusheim, 2026 Fourteenth street, Washington, D. C.

Each has some points of advantage, and the buyer must judge between them.

For the application of dry powders, where they are to be employed, some good bellows should be procured. The Woodason bellows is excellent, but the Leggett "Paris Green and London Purple Gun" is better than anything else that I have seen for applying dry powders rapidly, forcibly and evenly. This, however, is not so necessary as a knapsack sprayer.

Of insecticides, the arsenites are indispensable. Lime is also indispensable, not only as an addition to London purple, if that be used, but because of its effect on cabbage worms. It will replace hellebore on currant worms if applied in a fine powder.

Kerosene is also indispensable where scale insects are to be fought or subterranean forms to be reached, and this is really the only contact poison necessary. Fish-oil soap, as cheaper, may be added and used within its range as a substitute, but it cannot entirely replace kerosene.

These are all that are necessary, but not all that are desirable. Tobacco powder is a good thing to have; so is pyrethrum and white hellebore.

The potash salts should be on every good farm for fertilizers, and their use as insecticides adds nothing to a farmer's burden.

Besides the use of insecticides, methods of cultivation will do much to prevent or mitigate insect attack. Not the least of these is in the use of manures or commercial fertilizers. Decaying vegetable or animal matter, offensive as it may be in our opinion, is not repugnant to insects. On the contrary, it is strongly attractive to many forms, and has a tendency to attract to the fields hosts of species which live primarily on decaying matter, but sometimes under stress of hunger will take to sound vegetation as well. It should not be used on crops subject to root attacks—there is abundant room for its use without doing so. Phosphates are not repellants, and insects have no particular objection to them. It is otherwise with the nitrates and salts. These are decidedly disagreeable to insects, not in the sense of repellants, but because they are really effective insecticides in a limited range. The potash salts are by all odds the best for

this purpose. Nitrate of soda on wheat will do much to kill off root forms of wheat lice.

Many insects hibernate in the ground, or on or in stubble or stalks. These ought always to be removed. I am informed that where the corn-root louse occurs, it is always much worse the second year, where corn is planted on the same ground twice in succession. Doubtless the removal of the root masses would do much to prevent this. Fall plowing of fields infested by insects that winter in the ground is an excellent method of destroying many of them. Their cells are broken, and they are brought into direct contact with the cold and wet earth. Many are injured or crushed, and more are thrown on the surface, where they are at the mercy of insectivorous birds and mice.

With these remarks concerning insecticides, and the methods of application, the reader will be able to better understand the suggestions as to remedies in the other parts of this report.

The first pests to be treated are the

INSECTS AFFECTING SWEET POTATOES.

With the increased acreage annually put into sweet potatoes in this State, there has been a corresponding increase in the insect enemies. The latter are few in species,* and have all been well described by Prof. C. V. Riley in his second report on the insects of Missouri. I have simply verified his accounts during the present season, and have made use also of the same figures illustrating his paper, which could not be improved upon.

The complaints of injury have come from all sections of the sweet potato region, always of injury done just after the plants have been set out and while they are getting a start. At this time the mature beetles of all the species are found on the leaves, sometimes stripping the plants entirely, and often killing a large proportion of them.

The insects themselves are pretty objects, belonging to the *Cassidæ*, or tortoise beetles, and usually more or less golden glittering, one species, indeed, resembling in life a drop of molten gold.

The eggs are deposited on the leaves and covered with a protective excrementitious matter, giving them the appearance of irregular black daubs, not exceeding one-sixteenth of an inch in length. From these

* Since this report was prepared I learn that, in some localities, more injury is done by flea beetles than by the insects mentioned here.

eggs the larvæ hatch a few days later, and are as ugly and repulsive as the beetles are pretty and attractive. They are rather flattened, more or less oval and spiny, and furnished with a fork at the anal end of the body, usually carried as a shield turned up over the back, upon which is often piled the excrement voided by the larva and all the cast larval skins, so that when half-grown and more these larvæ are very repulsive in aspect. This habit has earned for them the common name of "peddlars."

The reason for this habit of carrying a shield of excrementitious material is, probably, that it serves as a protection from natural enemies, few birds or predaceous insects caring to attack such a filthy mass as these larvæ seem.

The most common of the species is

THE TWO-STRIPED SWEET POTATO BEETLE.

(*Cassida bivittata*, Say.)

The larva, or peddlar, is dirty or yellowish white, with a more or less intense grayish line along the back, usually relieved by an extra light band each side. It differs from the larva of all the other sweet

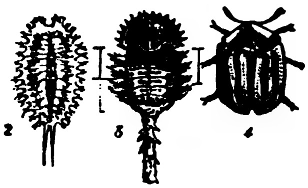

Figure 1.

Cassida bivittata: *1*, Leaf, infested by larvæ; *2*, Larva; *3*, Pupa; *4*, Beetle. *2*, *3*, *4*, Enlarged.

potato pests in not using its anal fork to accumulate a shield of excrement. The cast skins are, however, carried by the fork, which is inclined over the back at an angle of about forty-five degrees.

When full fed, this larva attaches itself to the underside of the leaf, and in two days the skin bursts open on the back and is worked down towards the tail. The pupa, at first pale, soon acquires a dull brownish color; the narrow, whitish tail, which still adheres posteriorly, being significant of the species. The beetle is a pale yellow, with two black stripes on each wing cover, and therefore obviously distinct from all the other species.

THE GOLDEN TORTOISE BEETLE.

(*Coptocycla aurichalcea*, Fabr.)

This species is rather less common than the preceding, and makes its appearance somewhat earlier in the season, beginning to decrease in numbers when the other is at its best. It is a much more active

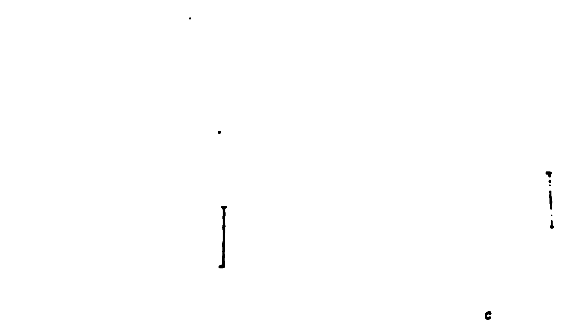

Figure 2.

Coptocycla aurichalcea: *a*, Larvæ, on leaf; *b*, Larva; *c*, Pupa; *d*, Beetle. *b*, *c*, *d*, Enlarged.

species and flies readily when approached. There are few more beautiful objects than this insect, when alive, in the bright sunshine; it seems almost transparent in the purity of its golden-yellow sheen; but this is entirely lost when the insect is killed, and it then seems of a uniform pale straw yellow. The larva is of a dark-brown color,

with a pale shade upon the back. It carries the anal fork directly over the back and the excrement is arranged in a more or less regular trilobed pattern. The loaded fork still lies close to the back in the pupa, which is brown like the larva, and chiefly characterized by three dark shades on the transparent prothorax, one being in the middle and one at each side. This species is not so commonly confined to the sweet potato, but is not rare on other species of *Convolvulus*.

THE MOTTLED TORTOISE BEETLE.

(*Coptocycla guttata*, Oliv.)

This species differs from the preceding in being more or less black-spotted, sometimes nearly all black, with the shoulders dark to the extreme edge of the transparent wing covers. It is more variable than the other species, but yet easily recognizable. The larva is of a

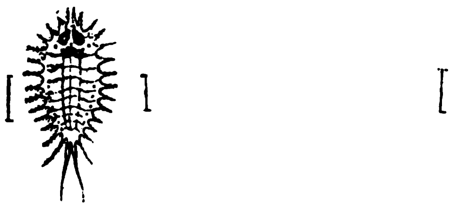

Figure 3.

Coptocycla guttata: Larva, pupa and beetle, all enlarged.

uniform dull-green color, with a bluish shade along the back, caused by the dark color of the stomach contents. It carries the excrement in irregular, broad, often branching masses, and previous to each moult and before changing to a pupa, this larva is in the habit of removing the excrement from its fork. The pupa is of a uniform dull-green color, with a conspicuous black ring around the base of the first abdominal pair of spiracles.

THE BLACK-LEGGED TORTOISE BEETLE.

(*Cassida nigripes*, Oliv.)

This insect is a little larger than those previously described. It has the same golden tint found in the *aurichalcea*, but less glittering

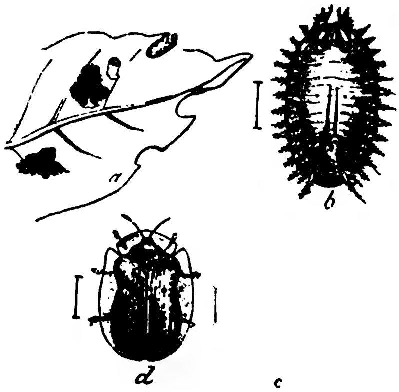

Figure 4.

Cassida nigripes: *a*, Larvæ, on leaf; *b*, Larva; *c*, Pupa; *d*, Beetle.
b, *c*, *d*, Enlarged.

bright, and there are three large, conspicuous black spots on each wing cover. The black legs, from which it derives its name, and the larger size, readily distinguish the present species. The larva is of a pale straw color with the long spines tipped with black. There are, also, a dusky shade along each side of the back, two dusky spots immediately behind the head, and below these last, two larger crescent marks of the same color. The excrement is spread in a characteristic manner, extending laterally in long shreds or ramifications. The pupa is dark brown, variegated with paler brown, while the spines around the edges are transparent and white.

GENERAL STATEMENTS.

The life history of all these species is practically the same. They make their appearance as beetles about the time the plants are set out, and continue for two or three weeks, or even longer, feeding constantly and laying eggs. These begin to hatch, and the larvæ are half or even full-grown before the parent beetles have disappeared. The pupa state lasts only a few days; the newly-hatched beetles feed for a short time and then disappear, no trace of them in any stage being found on the vines during midsummer or later. There is, in my observation, only a single brood of all of these species in New

Jersey, and the injury is all done early in spring. Larvæ and beetles, both, feed preferably on the under side of the leaves, eating little round holes at first, until the food becomes scarce, and then feeding wherever and however it becomes available. The sweet potato is a rapid and hardy grower, and may sometimes lose nearly all its leaves and again start afresh, showing little apparent signs of injury. But farmers say that the plants are retarded and weakened by this defoliation, often killed, and it certainly can be no benefit to a plant to lose all its first shoots.

REMEDIES.

The life history given indicates the remedy. The insects are on the plants in all stages, and feed exposed upon the leaves. The plants are quite hardy, and stand arsenites well. The only difficulty is in getting the application on where it would act most rapidly—*i. e.* the under side of the leaves. As the insects eat the entire leaf, poisoning from above will kill, though not so rapidly.

I should recommend Paris green or London purple, in the proportion of one pound to two hundred gallons of water, to be applied with a Cyclone nozzle. By using a knapsack sprayer, and a Cyclone nozzle so adjusted to the end of a stick as to enable it to be thrust under the leaves or in the very center of the plant, it could be rapidly and thoroughly poisoned. A simple sprinkling-pot will answer, of course, but it is wasteful and not so thorough. The application should be made as soon as the plants are well rooted, and when the beetles first make their appearance. The object should be to kill the adults before they can find a chance to lay eggs, and two applications at intervals of a week should be sufficient.

Second to none other in importance in this State are the

INSECTS INJURING SQUASH AND MELON VINES.

Squashes, pumpkins, cucumbers, melons of various kinds, and other plants of the same family, are largely raised in this State, and annually suffer considerably from insect attack. Some varieties of squash, notably the Hubbard, are so badly infested by borers that growing them has been abandoned in some localities. Even a half crop, however, is a paying one in ordinary seasons, and many farmers struggle

along as best they can, losing a large proportion and sometimes the whole of their planting.

The striped beetle and its twelve-spotted ally attack cucumbers and pumpkins almost before they are out of the ground, and sometimes eat them off completely, necessitating replanting.

After the vines have fairly started, melon and cucumber vines are attacked by a plant louse, which causes the leaves to shrivel and die, sometimes kills the vines, and often seriously affects the crop.

Chief among these injurious pests is

THE SQUASH BORER.

(*Melittia ceto*, Westw.)

Common and well known as is the larva or "grub," the parent moth is almost entirely unknown to growers. It belongs to the family of clear-winged, wasp-like moths, known as the *Sesiidæ*, and is prob-

Figure 5.

Melittia ceto, Westw.

ably mistaken for a wasp even when seen. In my own experience, the moth is seldom seen in the fields except in midday. The thorax is olive green or blackish. The body is tawny brown, with black spots on the upper side. The fore wings are brown or blackish; when in perfect condition, they have an olive-greenish tinge. In shape they are long and narrow. The hind wings are transparent, except the margins and the veins, and they are shorter and broader than the fore wings. The hind legs are fringed on the inner side with long orange hair, the spines covered with white scales, and these orange-tufted legs make the insect an easily-recognized and prominent one.

The colors are somewhat variable, but usually only somewhat lighter or darker than described. The annexed figure gives a fair idea of the appearance of the moth.

This insect makes its appearance in Southern and Central New Jersey about the middle of June, and a week or ten days later in the more northern parts of the State. According to Mr. Hulst, "the moths fly during the day, being the most active during the hottest sunshine, and quiet in the early morning. I have seen only two pairs mated, and this was between 2 and 3 P. M. The female lays her eggs, morning and afternoon, mostly on the stalk of the plant just below the ground. She extends her abdomen into the crack of the ground about the stem of the plant, and the most of the eggs that I have seen were from one-fourth to half an inch below the surface. Often, however, they were laid a foot above the ground, and in a few instances were observed upon the petioles."

The egg is oval and of a dull-red color. With a little training it can be readily seen. In a few days the egg hatches and the young larva makes its way into the stem at once, burrowing, preferably, downward into the root, but also upward and along the stem, where there is more than one. A single vine may harbor several borers—one hundred and forty-two have been found, it is said—and then it usually succumbs very rapidly. The moths remain about for at least three weeks, and seem to disappear in the Vineland region before the middle of July. The larvæ are of rather slow growth, and may be found in the vines up to the end of September, or even into October, although, as a rule, the end of August will see most of the borers full grown. They then leave the vines, burrow under ground for a short distance and spin a silken cocoon, using little chips and fragments of the vine to aid in the construction. In this cocoon the larva remains for a time before changing to a pupa, and the winter is passed in this quiescent stage. Next spring, when the temperature becomes sufficiently warm, they transform to the imago stage.

The borers themselves it is scarcely necessary to describe; they are only too well known by farmers. The first signs of their presence are noticed in the drooping of the leaves; the vine ceases to grow; the blossoms, where the attack is late, drop; the fruit does not set; eventually the vine is eaten off entirely, at the base, and dies.

Not all varieties are equally attacked; the Hubbard is the favorite. The summer squashes are nearly all very much troubled, and only

the later varieties are comparatively exempt. The unfortunate matter is, that the most susceptible is also the best and most profitable variety—*i. e.* the Hubbard.

REMEDIES.

Of the remedies for this insect attack, none have proved entirely satisfactory. Fall plowing is a most valuable process to mitigate the evil. The pupæ winter in the soil about the roots of the plants, and if this is thoroughly turned up and harrowed over, a very large proportion of the cocoons will be exposed to the action of the wet and cold. Not only that, but they will be laid open to the birds and mice, who are always about looking for just such tid-bits, and a very large proportion will undoubtedly be destroyed in this way. It has been stated that sometimes the borers pupate within the vine. As this may be the case, the vines should be raked off and put into the manure pit or on the compost heap, or they may be burnt.

As repellants to prevent the moth's laying her eggs, gas-tar has been recommended. This has been tried during the present season and it has failed. I do not believe that it would have any effect, from what I have seen myself of the action of the substance.

Paris green or London purple, persistently sprayed over the stems for a distance of two feet or less, has proved of some benefit in some hands, and of none in others. Plaster and Paris green used dry has proved ineffective in all hands. The London purple application, sprayed on, is intended to keep a poisonous covering on the vines, so as to kill the borer as soon as hatched from the egg. The theory is good, but, unfortunately, the borer seems to eat very little of the outer coat of the stem and to make its way in at once. Then, as the eggs are preferably deposited just under ground, the spraying may fail to reach the point selected by the borer. Spraying with the kerosene emulsion has also been recommended, and, according to Dr. Lintner, has proved successful in experiment. Col. Pearson has tried this and reports failure. I believe this can be used successfully. The kerosene emulsion has not been directly tested on these eggs, but it destroys most of those to which I have applied it, and I cannot see why the emulsion applied, say twice weekly, during the danger season, would not destroy all eggs on the vines. It is certainly worthy a trial.

The most successful remedy is cutting out the borer when the vines are seen to be infested. All who have ever tried it agree that the

vines will stand a great deal of cutting and that the wounds heal readily. Where a vine is noticed with drooping leaves the stem should be at once examined and the location of the borer determined by feeling for the soft spots. The vine should then be slit throughout the whole tract in which the borers have been working, until sound stem is found at either end. Of course all the borers in this tract should be killed—one hundred and forty-two are said to have been found in a single vine. This remedy is quite feasible, and has been successfully practiced in gardens. Where a large field is planted it is very laborious and requires daily attention during the danger season, for a vine once slit is not exempt from future attack.

Layering at the fourth joint has been practiced, with some success; but the testimony is by no means entirely favorable, since some growers claim that the vine does not mature fruit when severed from the main root. It has been found in Vineland that plants put in on the 12th of July, or later, are not attacked by the borers, the danger season being then practically over. The difficulty here is, however, that except in very favorable seasons, the fruit does not mature and an early frost would kill the crop as effectively as the borers. Especially is this true in the northern counties, where the season is short at the best.

In Bulletin 75 of the Station, the results of experiments made this year are given. They are not satisfactory; but on the whole the experience is not discouraging. If I can get a decent opportunity of making personal experiments, I think next season's work will solve the problem. At present the recommendations are: Destroy all old vines—roots as well as stems. Plow at least six inches deep, late in the season, and harrow twice if possible. Add a dressing of kainit if your next crop will be one benefited by this—*e. g.* corn. Plant next year's squashes as far as conveniently possible from last year's ground. As soon as your squashes are fairly started, layer at the fourth joint, enriching the ground, so as to give the best possible chance to root. I should now recommend spraying every three or four days during June and July—in South Jersey, say latter part of May, if squashes are then out, to the middle of July—with the kerosene emulsion, 1 to 12 of water. If borers are noticed, cut at once, as thoroughly as possible. This ought to insure at least a fair crop of squashes.

One observation, made at Vineland this spring, is suggestive and

worth recording. In searching a field planted in squashes the previous year, for pupæ, I found that in every case I had been anticipated by moles. I believe there was not a single hill which had not been visited by these animals, and I found not a single pupa.

Another seriously injurious pest is

THE STRIPED CUCUMBER BEETLE.

(*Diabrotica vittata*, Fabr.)

Nearly all growers of melons, cucumbers, pumpkins and squashes know this insect, and what they know of it is not good. This species does its most serious injury as a beetle, though the larva also feeds on these same plants. It is only about one-quarter of an inch in length, of a light sulphur-yellow color, with a black stripe on each wing cover, and a third on the middle of the back, where the wing covers join.

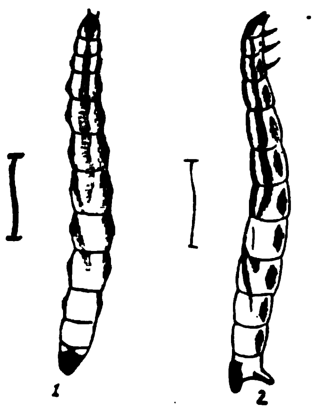

Figure 6.

Diabrotica vittata: Larva. *1*, From above; *2*, From side. Enlarged.

The beetle makes its appearance quite early in the season, before even the plants are out of the ground. They seem to content themselves for a time with a variety of food, until their favorites make their appearance, and then they attack the young plants as soon as they appear above ground. Sometimes, indeed, they do not wait so long, but actually burrow down to meet the young shoot, eating it off before ever it has seen the light of day. The insects are not com-

monly seen on the plants in numbers, but a very little stirring in the soil around the stem will bring to light an unexpected quantity, which take wing readily. These insects are more or less injurious every year, but seem to be less so in New Jersey than in some of the Western States. After the vines once get a fair start they keep well ahead of the beetles, and are not much injured. Now, however, injury from the larva is sometimes apparent. This is a slender, white grub, some two-fifths of an inch long, a trifle thicker than an ordinary pin, with a small brown head and an obtuse tail. It has six little brown legs on the anterior segments, and a short prop at the end of the body. These larvæ bore in the stem of the vine about the surface of the ground, and, when numerous, kill it. In about three weeks they attain their full growth, leave the stem, form little oval cells in the earth and change to pupæ. In this state they remain for about two weeks, and then change to beetles, making their entire period of growth from egg to imago, about six weeks. There seem to be in New Jersey two annual broods, the last maturing as larvæ late in fall, and these are said to hibernate as pupæ, remaining in the ground during winter, and changing to imagos in spring. I have not myself verified this life history, and believe that quite a number of the perfect beetles hibernate in that state. I have found them alive in midwinter, in concealment, and have found them crawling about so early in spring as to render it doubtful whether they emerged that season. The probability is that both methods obtain, and that while some of the beetles do live throughout the winter, the majority winter as pupæ. The larva has been found in the vines as late as October, and probably they continue until frost kills the plants, and with them many of the larvæ.

REMEDIES.

Quite extensive experiments have been made in Ohio by Mr. C. M. Weed, and in Iowa by Mr. C. P. Gillette, looking to a protection from injury by this beetle. Repellants have proved ineffective, and poisons were not satisfactory because of the insect's habits of burrowing to meet the sprouting plants. As the only real protection, netting stretched over an arch of wire or twigs in the form of a central croquet arch, is recommended. This is, of course, effective, and protects the plants until they have a start. The arches should consist of two

bent wires or twigs, crossing each other in the center so as to leave a tent-like space. Over this the fine netting is spread and kept down on all sides by a rim of soil raked on the edges. This method is an excellent one for use in gardens, or where only a small patch is to be protected, and is not very expensive. It need be applied only once, and lasts until the plants outgrow the tent. The same outfit will last for several years with reasonable care. In this state the plants are generally allowed to get a start, and, when this is the case, persistent spraying with London purple or Paris green will serve to keep them decently safe.

Mr. Mitchell, of Vineland, so protects his plants satisfactorily, and Mr. F. J. Kroboth, who made some experiments for me, writes of the Paris green and plaster: "Scattered among one hundred and eighteen hills (three to four vines each) of muskmelons, I have left ten hills to take their chance with the bugs; the remaining one hundred and eight I have treated according to your directions. The untreated hills are now totally destroyed by the striped bug, what appears to be its larva, a small worm, entering the steam near the root and working down; and another bug, larger than the striped, light yellow with black spots. The latter species of bug I have never seen before. Driven from the melons, they are to be found among my late cabbages, beans, tomatoes and egg-plants, apparently doing little or no harm. The treated hills are all doing well, having melons nearly ripe. The Paris green mixed in water is easier and quicker applied and more effective than mixed with plaster." Later on, Mr. Kroboth wrote that he was unable (August) to find a single striped beetle on his melons. There is no doubt at all but that either Paris green or London purple, sprayed on the plants, will protect against this beetle, where they allow it to get above ground.

Mr. Gillette has found that where the plants and the soil about them were sprayed early in the morning with a pyrethrum decoction, it killed the beetles. I have found that a sludge-oil soap, recently perfected, and not yet on the market, will do this at any hour of the day, and possibly, when the insects are very numerous, some such application may be necessary.

Mr. Neilson's gardener claims that a persistent use of tobacco dust kept his melon vines clear; and I have no doubt that this will act as a repellant to a considerable, perhaps protective, extent. This is also one of those cases in which fall plowing is useful, and in which the

removal of the vines, just as soon as the crop is off, will be decidedly beneficial.

Another insect, which has appeared in some numbers on the pumpkin and other similar vines, is

THE BOREAL LADY-BIRD.

(*Epilachna borealis*, Fabr.)

Nature plays queer and apparently unacoountable pranks sometimes. The lady-birds are, as a rule, the most useful allies of the farmers, feeding upon plant lice in every stage, and worthy of all possible protection. To this rule there is one exception only in our State, and that is the species whose name heads this paragraph.

This boreal lady-bird is about one-qnarter of an inch in length, almost circular in outline, or only slightly oval, and very convex. In color it is of a rather dull yellow, with large black spots, arranged in two transverse rows of five each, the largest central and really consisting of two that are confluent. There is also a black patch at the tip of each wing cover, and there are three black spots on the thorax.

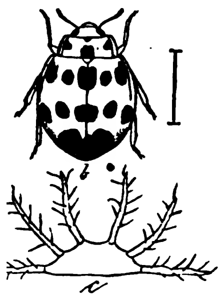

Figure 7.

Epilachna borealis: a, Larva; b, Beetle; c, Section of larva, to show arrangement of spines. All enlarged.

This beetle was very abundant at Jamesburg, early in July, on pumpkin vines, and was reported also from other localities on melons.

Its larva is a spiny slug nearly half an inch in length, of a dirty yellowish color, the spines darker and diverging. These spines are horny processes, set with little stiff bristles, and arranged in six rows, as shown at Figure 7, *c*.

It is rarely, indeed, that this species appears in noticeable numbers, and usually it is late in autumn, when seeking winter quarters in barns, on fences, posts, etc., that they are seen.

REMEDIES.

Whenever appearing in destructive numbers, this insect is easily controlled by an application of Paris green or London purple. It feeds exposed on the upper side of the leaf, and is therefore at our mercy. It may not appear as abundantly as during the present season for years to come, but it is well to know how to deal with it in advance.

The last, but by no means least-important, of the melon pests that I shall mention here, is

THE MELON APHID.

(*Aphis cucumeris*, Forbes.)

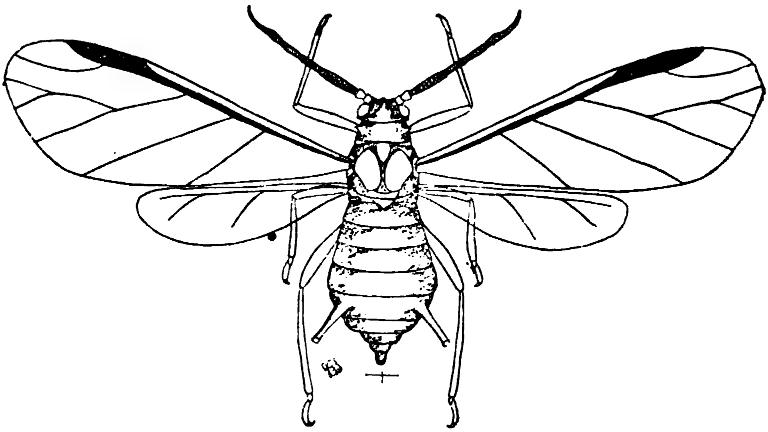

Figure 8.

Melon louse: Winged viviparous female.

This insect has been troublesome to growers for years past, and the remedies tried have not been remarkably successful.

The winged insect is of a brownish color, its general appearance and form as shown in the figure. The young are decidedly greenish or yellow when born, but soon darken until they reach the deep

chestnut brown of the mature form. The wingless viviparous females are shorter and stouter than the winged forms, but else do not differ essentially.

LIFE HISTORY.

But little is definitely known of the life history of this species. Prof. Forbes, who described it, knew only the asexual forms found on the leaves, and observed it during the summer only. He has, however, found specimens under ground, and finds that it gets worse in land planted twice in succession to the same crop. This argues that the hibernation is somewhere in the soil occupied by the melons during the summer. In this State they do not make their appearance on the vines until the latter are well along in growth; but then they multiply with such enormous rapidity that they soon exhaust the vitality of the leaves, and often of the vine. They disappear long before frost, indeed, soon after midsummer, and from that time their history is practically a blank to us.

REMEDIES.

The best remedy for this species is the fish-oil soap, in the proportion of one pound to eight gallons of water, put on with the Cyclone or Vermorel nozzle. A knapsack sprayer makes the best power to be applied, and if the remedy is applied in time it will prevent all injury.

INSECTS INJURIOUS TO THE GRAPE.*

EIGHT-SPOTTED FORESTER.

(*Alypia 8-maculata*, Fabr.)

It is rather curious that this insect should be so generally injurious in city gardens, and scarcely at all seen in vineyards. In the cities of New York and Brooklyn almost every garden with a vine is infested by this insect. Jersey City and Newark are as badly off, and I have heard of it from Paterson. Probably it is found, locally, all over the State. The moth is an easily recognized one, black, with eight white or yellowish spots, arranged as shown in the figure. It may be noticed flying about in the bright midday sun during June

*A statement of work done on the rose-chafer was prepared as part of this report; but, owing to delay in printing, it was withdrawn and makes Bulletin 82 of the Station.

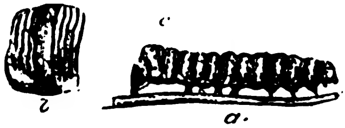

Figure 9.

Alypia octomaculata: a, Larva; b, A single segment, enlarged; c, Moth, natural size.

and early in July, making a pretty appearance among the flowers, and neglecting grapevines in the most innocent possible way. The larvæ or caterpillars are of a brownish or bluish tint, marked with narrow, transverse black, white and brownish lines, and with distinct little black dots on each segment, as shown in the figure. The larvæ become full grown early in August, and form a chrysalis in decaying wood where available, or just under ground, in a slight cocoon. There is only one brood in this State.

REMEDIES.

Where these insects are in small numbers, hand-picking is easiest and most certain where only a few vines are to be cared for. The period of hatching extends through nearly three weeks, and at least twice a week the vines should be examined. An easier way is to spray the vines with Paris green or London purple at the rate of one pound to two hundred and twenty-five gallons of water, adding a pail of milk of lime, if London purple be used. This can be put on with a garden syringe or one of the Whitman pumps with rose nozzle attached. Two or three applications, at intervals of one week, will be required. There is no danger to life in this use. The proportion of poison is very small, and is washed from the plants long before the grapes are ripe, none being absorbed by the plant. If, however, there is an objection to using arsenites, pyrethrum at the rate of one ounce to one gallon of water will be found effective against all larvæ on the vine at the time it is applied.

Bulletin K of the Station, issued early in the present year (1890), gave in a monographic form the results of the work during the season of 1889. Comparatively little was done during this season in the way of further investigation; but a great deal of correspondence was had with growers in reference to the application of the matters referred to in the bulletin. On Cape Cod two of the newspapers reprinted the bulletin almost in its entirety, and many letters were received from that region.

The principal feature of the year was the unusual injury done by grasshoppers, crickets or katydids.

Of the fact of the injury, there is, unfortunately, no doubt. I have seen acres in which fully three-fourths of the berries were scooped out; but as to the insect that does the damage opinion differs widely. At the meeting of the American Cranberry Growers' Association, in August, 1890, some accused the grasshoppers, some the crickets, while only a few seemed to consider the katydid responsible. Yet my own observations make this insect the chief offender. The small, green meadow grasshoppers are very abundant in grassy spots; but I could never find them eating berries, nor could I, on dissection, find that berries seemed to form any part of their food. Indeed, as the grasshoppers often actually outnumbered the berries in spots where only few berries were eaten, it is evident that had their food been berries, there would have been no berries remaining. Of the crickets, I could rarely find one in the middle of the bogs, where the damage was greatest. Of the larger grasshoppers, none that I dissected showed any trace of berry food. Katydids, however, in all cases had the stomach distended by berry food, easily recognizable by the seed fragments. It is the seeds that these insects are after, and they eat into the berry to get at the seed capsule, eat out this, and then go to another berry. I have seen bunches of five or six berries, of which four had been scooped out, evidently at a single meal! Now, even if such a meal be eaten only on alternate days, the number of berries that a single insect, during the three weeks it is nearly or full grown, can dispose of, is considerable. Other species may help, but I am inclined to believe that the katydids are the chief offenders.

Now, as to the breeding-places of all these insects, of which also very differing statements are made. It is necessary to premise that in the order *Orthoptera,* to which all these creatures belong, the egg-laying habits differ. There are two very distinct families represented in the grasshoppers found on the bogs. Those with little short horns or feelers are *Acrididæ,* or true grasshoppers; and of those found on the bogs, all lay their eggs in pods, under ground. I do not believe that any of these oviposit on the bogs, for I have never seen the very young there, and believe that, even if the eggs were laid on hard and dry parts of the bogs, the winter flowage would destroy them. But they are laid along the edges, in the dams and on the banks which are not reached by the water. The second division of the *Orthoptera* has very long, slender horns or feelers, much longer than the entire insect —these are *Locustidæ,* or true locusts, and these differ entirely in their egg-laying habits from the *Acrididæ.* The katydids and the green meadow grasshoppers are both locusts, in the entomological sense. The meadow grasshoppers which are so excessively numerous, undoubtedly breed on the bogs. The eggs are laid in the grasses,

Figure 10.

Katydid: *Microcentrus retinervis.*

which are so plenty on ill-kept bogs, and there they pass the winter safely. But not only in the stems of grasses, but in those of other plants, or in a decaying stump—any such place as a decently soft bark or wood serves these insects as a *nidus,* and hence the young are seen on the bogs in enormous numbers, and there they remain throughout their life. Now, if berries formed any considerable part of their food, there would not be a berry remaining on the bogs before the season was half over. Yet I have seen them rise by the hundred before a gang of pickers in good picking—all sound berries.

The katydid habit of laying eggs is different from all the preceding, as the insect is different from the others described. Here the large, somewhat lima-bean shaped egg is laid in series on twigs, as shown in the figure, or along the edges of a leaf, or on a fence corner, or, in fact, anywhere that seems to afford a good or convenient place. Even the belt of a lady's sewing machine, standing near an open window, has been selected. On bogs on which brush of any kind remains, many of these insects undoubtedly winter in the egg state. I deem it scarcely likely that the eggs could survive being submerged during that season, and believe that the katydids on well-kept bogs come on from the edges.

Crickets lay their eggs in the ground, as do the true grasshoppers, and, like them, principally along the sandy banks or edges of the bogs.

Figure 11.
Eggs of katydid.

REMEDIES.

These are not easy insects to deal with when on the bogs. Spraying with arsenites is a theoretical remedy, and perhaps a practical one. It means, if used, that a coating of arsenic must be kept on the berries almost to picking-time. This would be difficult, expensive and there would be the very serious danger of injuring the pickers, for the poisonous particles that might get into the torn or scratched hands would cause ugly sores. There is a more effective way, and that consists in keeping your bogs so free from weeds, shrubs and grass as to afford no chance of wintering upon it, and have a wide enough marginal ditch all around to prevent unfledged insects from coming on from the outside. Flowing for a day or two just after picking would kill off whatever might then be alive on the bogs and prevent much depositing of eggs. In some cases there is an ample water-supply to flow within twelve hours or even less. Where this is the case with badly-infested bogs, and a rainy spell be chosen (for notice of which apply to the State Weather Service), bogs can be reflowed for twenty-four hours, after all the berries are set, without much danger of injury. Flowing in hot, clear weather would mean loss of crop. Bogs should never be flowed when in blossom.

TIP WORM.

There has been among some growers a very strong conviction that I had underestimated the damage done by the tip worm, and Mr. A. J. Rider, Secretary of the American Cranberry Growers' Association, contended to this effect very strongly at the August meeting. Early in September I accompanied him to his bogs near Hammonton, and was piloted to those portions on which the tip-worm injury was most

a

b

Figure 12.

WORK OF TIP WORM.

a, Cranberry vine—tip gone completely; *b*, Vine, showing appearance of infested tip; *c*, Loosestrife infested with tip worm; *d*, Same, showing flower buds struggling out; *e*, Tipped vines, with forming fruit buds at axils of leaf.

apparent. There was no question of the fact—tipped vines, most of them, bore no fruit buds. It was also as evident, however, that a large proportion of the vines without fruit buds had not been tipped! In other words, the vines were sluggish, not vigorous, and really not in condition to bear fruit under the best of circumstances. Examining the best parts of the bog, where the fruit crop is good year after

year, I found nearly or quite as many tipped vines as before; but these, almost without exception, were showing lateral fruit buds fully as good as on normal vines. It was only where the tipping had been very recent that there was no bud. There were many fine fruit stalks that had evidently come from one of last year's tipped vines.

I must, after another season's observation, still hold to my original belief that this insect does little injury, but will now qualify by adding on normally healthy and vigorous vines.

EXPERIMENT RECORD.

In order to test some of my recommendations, and also the effect of late holding the water, I induced Mr. Buckelew to allow me to make an experiment with his bogs at Jamesburg. These are five in number, covering nearly one hundred acres, in a single series and all flowed by a rather small stream. On April 18th, I examined the arrangement of bogs while the water was still on, found that reflowing the whole system was out of the question, but that part, at least, might be recovered. The difference in level was twelve inches between first and second, fifteen inches between second and third, six inches between third and fourth, and eighteen inches between fourth and fifth.

The weather was agreeably warm; the water along the edges was quite high in temperature, the buds were beginning to swell, and little suckers were being sent out by the vines in favorable locations. On some vines, fished out at different depths, I found a number of eggs, all of which were sound.

April 26th. On the lower three bogs, the water was started off, the instructions being to draw just as rapidly as possible, so as to lay all bare at the same time.

At this time the weather was very genial, and a rapid start was anticipated; but the temperature changed, and it became chilly and cloudy, and so continued. On the 10th of May, the buds had scarcely started anywhere on the bogs, except a little on the highest of the three.

May 17th. Everything still very backward, except on the vines along the banks. These have fairly started, and here the larvæ are out and some are nearly half grown. The unfortunate point was, that on the upper two bogs on which the water was held as in a reservoir, the more even and warmer temperature brought out the buds

and shoots much more rapidly than on the uncovered bogs. Shoots projecting above the water were growing rapidly, and those near the surface were starting.

May 23d. The cloudy and chilly weather continues, and there is no *life* in the plants. Larvæ are, however, hatching abundantly all over the bare bogs, and are beginning work; they are still very small, and, in my opinion, there should have been at least three days more chance for hatching. But the reservoir bogs were growing so fast under water that Mr. Buckalew's foreman predicted the killing of all chance of a crop on them, if the water was left on much longer. I tried to save twenty-four hours more by giving him permission to draw from the reservoir bogs to 3 and 4, if it rained. It did rain, and the upper bogs were drawn on to 3 and 4; the water was left for twenty-four hours at full head, and then drained from 3 and 4 to cover 5, which was also left for twenty-four hours entirely covered.

June 6th. All the bogs are dry. The reflowed bogs are looking finely, setting buds freely, and some already beginning to bloom. The drawing from the reservoir bogs had a great deal of the bad effect anticipated by Mr. Connarty, the foreman. A large proportion of fruit buds were undoubtedly killed by the late holding. They were those which had started rather close to the surface in the warm water. Where the tips had projected beyond the water there was little injury, and in the low parts of the bogs the vines had not started before the water was drawn. Fully half the fruit buds, however, were killed. On the other hand, on the lower, reflowed bogs, larvæ were very scarce and scattered, indicating by their size that if the bogs had been left dry for two or three days longer before reflowing, they would have been cleaned out entirely. On the upper two bogs, from which the water was not drawn until May 23d, there were many more larvæ, but here the late holding had been of undoubted benefit, and there was nothing like the number of last year.

Mr. Connarty had been spraying the infested patches as fast as they were noticed, with London purple and Paris green, and was getting the better of the young pests in every direction. Later, the lower bogs were one solid mass of blossoms, while even the upper bogs had a very encouraging appearance. A very large crop set, which was practically free from injury by the fire worm, for spraying had kept under the few spots in which they started. Scald primarily and grasshoppers next, reduced the crop quite disastrously; but the man-

agement and applications against the fire worm were absolutely successful. The same point already insisted upon forced itself to the front again very conspicuously:

To make spraying successful against these cranberry pests, it is necessary to make the application just as soon as they are hatched, and before they get the leaves webbed up.

PEACH INSECTS.

Some of the peach orchards, although they bore no peaches, were yet very much injured by insects. The injury was the more dangerous as, generally, its true cause is not suspected. The so-called "yellows" of the Jersey grower, is not at all the specific disease of that name, but is usually due to

THE BLACK PEACH APHIS.

(*Aphis persica-niger*, E. F. Smith.)

This insect has been unusually abundant this year, and has caused some complaint. It has also done a good deal of injury that was not suspected, since much of its work is done on the roots of the trees. Dr. Smith, its describer, speaking of the injury caused by them, says: "In Delaware, Maryland and parts of New Jersey and Virginia, this aphis was reported everywhere to be unusually prevalent and destructive. In April, when the leaf buds were pushing, I saw them clustered upon so many shoot axes, and so compactly, as to kill young trees and even very considerable branches upon older trees. They were especially destructive to nursery trees and to orchards just planted. I saw one nursery in which at least 100,000 trees had been killed outright in two or three weeks' time. I also heard of half a dozen large nurseries which were entirely destroyed or very seriously affected, and of orchardists who will be compelled to replant hundreds of trees." In New Jersey I have heard of serious injury to nursery trees in Monmouth county, and of injury to young orchard trees in Cumberland and Burlington counties. From my own observations this year, I think that much of the sickly appearance of the trees in the sandy regions is due to the injuries caused by this insect. Again, quoting from Dr. Smith: "Such trees are

Figure 13.

Peach louse: Winged viviparous female.

badly dwarfed and make only a feeble, sickly growth. The leaves are light green or yellowish, more or less rolled at the margins, and red or purple spotted from the attacks of fungi." Late in May I found them in great numbers on some trees in Vineland, clustered on the young twigs to such an extent as to check growth entirely, and had they not been destroyed they would have assuredly killed the twigs and perhaps the tree. It behooves growers of peaches to be on the lookout for this pest, and to adopt active measures for its destruction.

DESCRIPTION OF THE SPECIES.

The winged form is well represented in the figure, so far as shape and general appearance are concerned. It is of a shining black or very deep brown. The legs are deep brown on the thighs, the tips of the shanks and the tarsi, else yellowish. The cornicles or honey tubes are quite long, moderately slender and of the same color as the body. There is a series of deep pits on each side of the abdomen.

The wingless form differs in the somewhat stouter body, but is very generally like the winged type in color and general structure. The young are of a faint greenish brown, becoming darker as they

grow older, until they are of the typical shining blackish peculiar to the full-grown specimens.

The antennæ of the winged form have the sensory pits extremely developed, every joint beyond the basal knob joints being furnished with them.

The figures will show the number and arrangement of these pits, which are larger than in any other species known to me and so numerous as to give a knobby appearance to the first long joint.

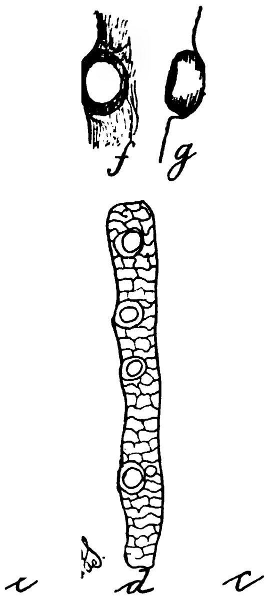

Figure 14.

Peach louse: *a*, Antenna of young lice; *b*, First long joint of winged form; *c*, Second long joint; *d*, Third long joint; *e*, Whip joint; *f*, Sensory pit of antenna, from top; *g*, Same, from side.

These pits are not simple openings or depressions, but there is a round or oval opening in the body of the joint, and in this is a capsule, covered with a fine, transparent, tightly-stretched membrane, something like a drum-head.

In the wingless forms the antennæ have only the usual single pit on the third long joint and the little group on the whip joint.

LIFE HISTORY.

This species is found on the roots of the trees throughout the year, and it breeds there quite undisturbed. Early in spring, or when the leaf shoots begin to start, they make their way to the surface and to the branches. Here the winged form develops, and this makes its way to new quarters, founding colonies wherever it reaches, and these, about midsummer, make their way to the ground and to the roots. Usually some few specimens are to be found on the leaves throughout the summer, but they are much the most abundant in spring.

Dr. Smith states that these pests are attended by an ant which facilitates the distribution of the root form, and aids it in getting to the surface in spring.

No males of the species have been observed, and no eggs have been found. We know that it breeds agamically all the year around, and no quiescent period has been as yet observed.

REMEDIES.

The dealing with this insect above ground is easy. It succumbs readily to either the kerosene emulsion or the fish-oil soap, and the application of the insecticides to peach trees is usually not difficult, because of their moderate size. The young trees suffering most, can usually be reached with the power afforded by a knapsack sprinkler. In nurseries where this insect is working on the roots, I should recommend liberal periodical dressings of kainit. This will not only act as an efficient fertilizer, but will also serve to destroy many of the lice. The application should be made just before a rain if possible, so that the salts can be at once dissolved and carried into the ground. Wherever the solution comes into contact with the aphides it will kill them, and the salts will remain until taken up by the plant. The kainit is better than the muriate because it contains more salt, and at the same time it seems less likely to injure vegetation if put on too heavily. The application should be made when injury to the trees is noticed—*i. e.* when they look sickly, refuse to grow without apparent cause, or when an examination shows the presence of the lice in the orchard.

Since Bulletin No. 72 was issued, I have talked with a number of

peach-growers, and I am convinced that much of the specific effect of kainit as a peach tree fertilizer, is due to its insecticide qualities in killing off the infesting root aphids. It has been found that where young trees have refused to grow in old peach ground, a heavy dressing of kainit has mended matters radically, and a healthy young tree has been successfully grown.

THE PEACH BORER.

(*Sannina exitiosa*, Say.)

This insect, treated in the last annual report, is mentioned here only to record the fact that some growers near Allentown have prevented injury by whitewashing the trunk around the base, adding a spoonful of Paris green to the pail of whitewash, and hilling up around the tree, so that two or three inches of whitewashed trunk shall be under ground. This must be done in May, and the whitewash renewed as needed until the middle of July. It is effective as a poisonous mechanical covering to the trunk.

WHEAT INSECTS.

The wheat louse is one of those known pests that at irregular intervals make themselves unpleasantly conspicuous, and cause considerable damage when they do appear.

The season of 1890 will be a memorable one for its irruption of this insect and for the abnormal abundance of plant lice of all kinds.

THE WHEAT LOUSE.

(*Siphonophora avenæ*, Fabr.)

The invasion was serious only in the southern and western counties, and little damage was done in the region of New Brunswick and northward. Poor wheat suffered most, and rye seemed to be very susceptible to injury.

DESCRIPTION OF THE INSECT.

For the general appearance of the winged form the figure is the best description. In color it is green, varying in shade, with a large egg-shaped, black spot on each side of the thorax, and with a row of

Figure 15.

Wheat louse: Winged viviparous female.

blackish dots on each side of the abdomen. The antennæ are about as long as the body, the legs with pale-greenish thighs, and with dull ochre, black-tipped shanks.

The wingless forms have much the same shape as in the case of the others, but are more uniformly grass green in color. The very young lice are proportionately more elongate and somewhat deeper green in color.

At the sides of the abdomen, near the tip, are the honey tubes, two moderately long organs from which many of the plant lice excrete a sweetish liquid of which the ants are very fond. This accounts for the fact that ants are so often seen on plants frequented by lice, and these latter are never on any account injured by the ants, but are protected and carefully cared for by them.

The antennæ, or feelers, have in the winged form a series of pits or sense organs at the lower half of the first long joint. On the third long joint is a little aggregation of pits near the tip, and on the enlarged basal portion of the last, or whip joint, is another series of pits. In the wingless forms these pits are present only in the last or whip joint. The antennæ are further curious and interesting from being densely covered with scale-like markings. These pits are sense organs of some kind, and most likely connected with the sense of

smell. They may be of use to enable the insects to identify their food plants on their migrations, and for this the winged forms only need the organs.

It has been already stated that the injury to the plants is done by piercing the leaf or stem, and sucking the juice. By turning a louse bottom up the beak can be seen starting from the underside of the head and extending backward between the fore legs. The beak is three-jointed and is shown, Figure 16, *a*, in a front view. It will be

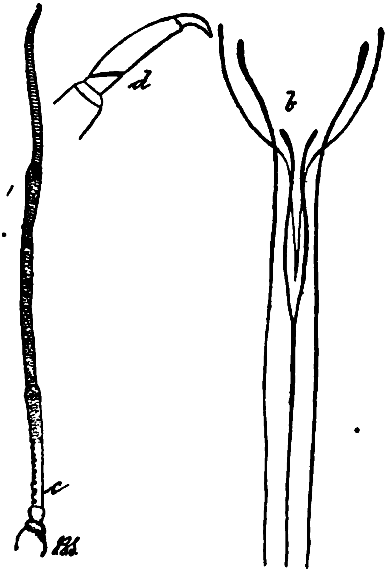

Figure 16.

a, Proboscis of wheat louse; *b*, The lancets contained in it; *c*, Antenna, showing the sensory pits; *d*, Tarsus.

seen that it is not a solid tube, and that there are three joints. The one nearest the body is much the longest, and strengthened by a chitinous rod through the center. The middle joint is short, with a curious flap on each side and several tactile hairs. The terminal joint at tip is furnished with minute saw teeth and sharp projecting edges, perhaps to enable the insect to keep a better hold.

Within this tip are three fine, hair-like lancets, of which the lower is really composed of two, grown together, and these are the true

piercing organs. Of course these are very delicate structures and apparently not very strong, but they are sharper than the finest needle and can pierce the plant structure with little or no effort.

LIFE HISTORY.

We do not know the complete life history of this species, and we do not know the male. We know that it makes its appearance on winter wheat when it is out of ground, flying from we know not where. These winged lice are few in number and they do not breed very fast. As winter approaches, the lice crawl downward along the stem, and get under ground on the roots. These root forms are wingless, and they continue their work under the snow, and, whenever mild weather prevails, bringing forth young. With the approach of spring, they crawl upon the leaves and stalks, winged forms appear, and they scatter, seeking fresh fields, where they multiply greatly. They disappear before the wheat is harvested, and what becomes of them at that time we do not know. There never was a male of this wheat louse known, and there never was any evidence that the species ever has a true egg state.*

CAUSES OF INVASION.

What has been said under the head of life history, gives a clue to the reason for the unusual increase during the season of 1890. Normally, few specimens get upon the wheat in fall, and with moderately cold weather they are soon driven under ground and cease breeding. When they re-appear in spring, they do not get much of a start before their natural enemies are about, and do not become injurious. In the winter of 1889–90, the temperature was such that, though the natural enemies of the lice kept close, the lice themselves were active almost the entire season and did much to exhaust the vitality of the wheat even before growth began. Then when they appeared above ground they were in such enormous numbers that they overran everything and got way ahead of natural checks for a time. But, with the season, the various parasites and predatory insects made head against the lice until they cleaned them out nearly enough to do away with all reason for fear.

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* Since this paragraph was written, the true sexes and the eggs have been discovered, and the under-ground habit is now doubtful.

PARASITES AND NATURAL ENEMIES.

Of the parasites the most active is *Aphidius granariaphis*, Cook, or the grain-louse *Aphidius*. This is a small, black, four-winged fly, with long feelers and quite large wings. It is scarcely one-eighth of an inch long, but very active, and might be observed busily flying

Figure 17.

Aphidius granariaphis, showing above the parasitized louse from which it has issued.

about the infested wheat heads, dealing death all around. This little fly lays a single egg on a louse, this hatches and produces a little maggot, which feeds on the rich juices of the plant louse until it is full grown, then changes to a pupa, still in the body of its host, from which it eventually emerges through a round hole in the body of the

louse. Long before the fly hatches the infested lice may be known by their livid gray color and their smooth, swelled appearance. Immediately on emerging these little ichneumonids pair and the females at once begin ovipositing on the lice.

Another little ichneumon, much less abundant than the preceding, but a noble worker, nevertheless, is the *Ceraphron triticum*, Taylor,

Figure 18.

Ceraphron triticum.

the wheat-louse *Ceraphron*. This is also a black, four-winged fly, but very different in form and somewhat smaller than the *Aphidius*. It is much stouter, the abdomen shorter, wings smaller, legs thicker and the antennæ very different in structure. The difference between the two is well seen by a comparison of the figures given. The life habits are practically the same as in the *Aphidius*. How many generations there are of these parasites, or how they pass the winter, we do not know, but they are to be found as long as there are any lice on the plants.

Among the natural enemies which are predaceous rather than parasitic, the larvæ of the *Syrphus*, or flower flies, stand first in rank These larvæ are generally overlooked, and they are better known by their deeds than their appearance.

In shape they are slug-like, tapering toward the head. There are

no distinct feet, and the larvæ stick rather close to the leaves or on the wheat heads, and remain concealed among the spears and flowers. When they are hungry, which is generally the case, they lift the head and first segments of the body and extend them out in every direction, the larva nearly doubling in length when so stretched out. Any unlucky aphid within reach is pounced upon, caught with the jaws of the larva and lifted high in the air, where it kicks and struggles until its juices are sucked dry. The empty skin is then thrown away, and

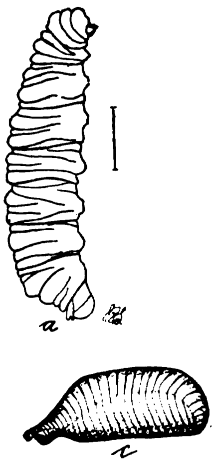

Figure 19.

Syrphus torvus: *a*, Larva, from side, showing the wrinkled appearance; *b*, Same, from above; *c*, Pupa.

the larva is ready for the next victim. In color this creature is a very pale yellowish green when young, darkening in color and becoming mottled with reddish purple as it matures. It is then about half an inch or less in length, transversely wrinkled and with a very rough skin, set with minute, bristly little hairs. When it is full grown it fastens itself to the leaf or spear of wheat upon which it has lived, and curls itself up, contracting into a curious hard case of a dark-gray color, and rather more than one-quarter of an inch long. Figure 19, *c*, gives the appearance of one of these pupæ. Not long does it stay in this form, but in about eight or ten days a pretty bronze and yellow fly emerges.

This fly is nearly half an inch in length, the head entirely taken

Figure 20.

Syrphus torvus: Mature fly.

up by the large brown-red eyes, the thorax shining bronze, but covered with a fine, velvety, soft hair, the little lunate scutellum at the tip of the thorax yellow. The abdomen is also bronze, but each segment with a broad yellow band, that on the basal segment being usually broken in the middle. The figure will give a very good appearance of the fly as it appears at rest. It hovers about the wheat in the bright sunshine, and the female lays its long, oval, pure-white egg wherever she spies a colony of lice large enough to support the young larva when hatched.

The mouth of this larva is quite complicated compared with the simple suctorial mouth of the "Horn Fly" larva, which was figured in a previous bulletin (62). Here the jaws are well developed, so that they can firmly hold the prey, while the mandibles ply between the jaws, quietly chewing the struggling aphids. Next to this species, in my observation, is the nine-spotted lady-bug (*Coccinella novemnotata*), which is more usually noticed, and which undoubtedly did much to clear out the swarms of aphids this year. The pretty red beetle with the black-spotted wing covers is well known to all who make any pretence of observation, and its good work can scarcely be overestimated. Less noticeable, but even more effective, is its larva, which is not so generally known. It is a long, blackish, somewhat flattened,

Figure 21.

Syrphus torvus: Mouth parts of larva; *a*, The complete mouth; *b*, The upper jaw; *c*, The mandibles.

active creature with six distinct legs, which it extends to quite a distance each side of the body. The figure gives a generalized figure of the lady-bug larva, our common species of which have much the same color and form. They are all blackish or gray, with whitish and

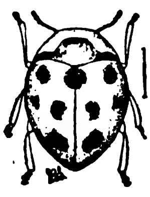

Figure 22.

Coccinella 9-notata.

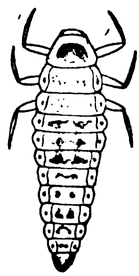

Figure 23.

Lady-bug larva.

reddish irregular markings. They are very rapacious and are eating almost constantly. When full grown, they coil up into a little ball on a leaf or other convenient place, change to a pupa, and soon after to a beetle. These beetles live, during winter, in crevices of trees,

boards, or wherever a shelter can be found, and thence they emerge early in spring ready to provide for a new generation.

To the species already enumerated might be added a number of others which aid in keeping the aphides in check; but they are of so much less importance than those above described that it is scarcely necessary to do more than mention their existence.

REMEDIES.

There is a difficulty in the way of applying artificial remedies for this insect, caused by the space to be covered and the quantity of insecticide needed. The general farmer will submit to loss rather than make any effort to apply insecticides on a large extent. Yet, spraying a wheat field is not so hopeless a task as it appears. There are a number of geared tank machines on the market which make a good spray and can be driven through the fields at a quick walk. In drill wheat, while it is small, there would be little or no damage done by the wagon, while it would be possible to destroy so large a proportion of the lice with one application, even, that they would multiply so slowly for a time as to give their natural enemies a chance to conquer them. The time for the application is when the lice are first noticed in numbers on the wheat. The application may be either whale-oil soap or kerosene emulsion, in the proportions recommended in a previous part of this report.

In addition to the above application, or in case no insecticide application is made, I should recommend a tonic in the form of nitrate of soda, 100 pounds to the acre. The object of this is to stimulate the plant and enable it to resist the drain upon its vitality. The nitrate should be put on late in April or early in May, and the good effects will be noticeable within a very few days. It would seem to be almost unnecessary to urge farmers to get a rank, healthy stand of grain; but it is certainly a fact that such grain suffered comparatively little, since it had plenty of life to hold its own until the lice disappeared.

Finally, as a grain of comfort, it is altogether unlikely that there will be a similar visitation next year. Not only were they decimated by their natural enemies, but unless we have another exceptionally mild winter, the aphides will scarcely find again the same favorable conditions for an abnormal increase.

CABBAGE INSECTS.

The cabbage worm, the cabbage maggot and the cabbage louse, all form the subject of frequent inquiry. These insects have all been treated in Bulletin 50 of the Station, and I will not attempt to cover ground already gone over there, but will in the case of the cabbage louse give a more complete life history, with further suggestions as to remedies; and in the case of the cabbage worm will give only a note on some insecticides tried this year.

THE CABBAGE PLANT LOUSE.

(*Aphis brassicæ*, Linn.)

This insect has been unusually abundant during the year. The plants were sometimes so crowded with the lice that it was impossible

Figure 24.

Cabbage louse: Winged viviparous female.

to see the leaves, and the plants were so devitalized that they failed to grow. It appeared early in the year, and was especially destructive to the young plants grown for transplanting. Turnips and radishes suffered to a less extent, but always very severely. The complaints

were greater of the early plantings than of the late, though many heads were stunted and rendered unfit for market.

Complaints began in April and continued well into August. Damage was especially severe on young plants just set out, and many had to be replanted. I found it abundant on late cabbages in September, and it is known to be about until frost. Dr. Riley says on this point: "Late in October, 1871, we noticed great numbers of this aphis flying in the city of St. Louis, filling the air in every direction and flying into people's eyes and ears. The weather had been very warm previously, and as late as the middle of November the plants in the turnip fields around the city were swarming with the lice." It is therefore about during warm weather, the period varying according to the season. It is most abundant earlier in the season, for the same reason that the grain aphis was then most injurious—*i. e.* before the parasites and natural enemies had increased sufficiently to act as a check. These enemies become most abundant during midsummer, but at this time the plants suffer little, and the late cabbages usually get beyond reach of serious damage. The injury is marked all over the State, but perhaps worst in Southern and Central New Jersey, where the decidedly warmer winters favor the development of the *aphides.*

DESCRIPTION OF THE SPECIES.

The wingless viviparous female is rather a long oval in form, of a greenish-gray color, with a series of black spots on each side of the back, becoming larger in size toward the tip. This coloration is usually obscured by the whitish, mealy or waxy secretion which covers the body of these insects. The antennæ are green, with black tips, and the eyes and legs are black.

The winged viviparous female is yellowish-green, with the eyes black, the lobes of the thorax, the honey tubes and the legs brown. The general appearance of this form is shown in the figure, which also brings out well the differences between this species and the grain louse. This is most noticeable in the size of the honey tubes as compared with other species, those of the cabbage louse being much smaller and different in shape.

In the structure of the antennæ there is also a great difference, for whereas in the grain louse there were but a few sensory pits on the first long joint, in the present species they are very numerous all

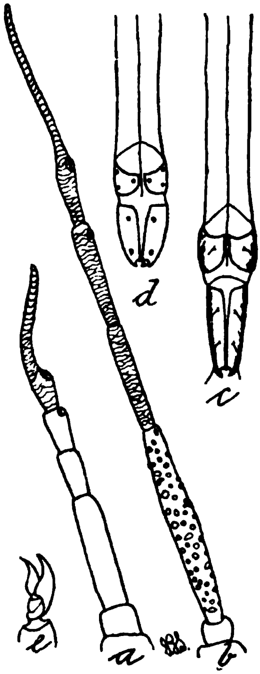

Figure 25.

Cabbage louse: *a*, Antenna of wingless forms; *b*, Antenna of winged forms; *c*, Beak of young lice; *d*, Beak of winged form.

around the segment; those of the third and fourth joints being about the same. On the wingless forms there is only one large sensory pit on the third long joint, and the usual little group on the whip joint.

Not only in antennal structure, but even in the structure of the beak itself, this species differs from the grain louse. The terminal joint is longer; the second simple, without the peculiar flap figured in the other species. The beak is also longer, and more slender, in contrast with the antennæ, which are shorter and stouter.

LIFE HISTORY.

This insect has been known in our country since 1791, and is as common in Europe as it is in the United States; indeed, it is probable that the species has come to us from Europe, and yet we do not

know its full history. As in the case of the grain louse, no one has ever seen a male, and no one knows whether at any time eggs are laid, or if there are, what they look like. So far as I am aware, we do not know where the winter is passed.*

REMEDIES.

Like the grain louse, this species has its natural enemies; but they are like in general appearance and character to those of the former, and need not be especially described here.

Unlike the grain louse, we can here do very much more with insecticides, and indeed, with care, can keep the insects completely in check. One of the best of the remedies is the whale-oil soap of commerce, or the soap of which the formula is given on page 467. The kerosene emulsion is equally effective, and for penetrating power is even better. In all experiments made for me this season the result was uniform and the effect satisfactory. I shall not give the results of these experiments in detail here, as they are recorded in Bulletin 72. It will be enough to state that the fish-oil soap was perfectly effective at the rate of one pound of soap to eight gallons of water. Another very satisfactory remedy was found in ground tobacco. This was used with excellent result, put on early, while the plants were wet, and dusted on thoroughly. It has the great advantage of being a fertilizer as well as an insecticide, and one of my correspondents who made the experiment, writes May 18th: "I have no cabbage lice at present. I first commenced with the tobacco mixture, and after two or three applications that row has done fine; they are now as large around as a truck basket." Regarding the whale-oil soap, the same correspondent writes: "The whale-oil soap was put on another lot; the first application did not kill all of the lice, so the next day we put it on again as you directed, which has killed them all, and the cabbage is doing nicely. This is a sure remedy. I let some others have some of it with the same result." We are therefore not without a remedy for this pest; but many complain that the difficulty is in the application. The lice get under the leaves or curl them, and the spray does not reach them. The remedy is to use the modern machinery for applying the insecticides. For spraying insecticides on cabbages, a knapsack sprayer is necessary, and to this a Cyclone

* The sexual forms and the eggs have been found and described since the above was written, and the life history has been completed.

or Vermorel nozzle should be attached. This nozzle, at the end of a stick of convenient length, can be passed all around and into the cabbage plant, sending a fine spray into every corner. A man can go over a large field, stopping only a few seconds at each plant and wasting no liquid. This matter of nozzles and spraying apparatus has been enlarged upon in the insecticide bulletin. I have here indicated what the remedies are. As to time of application, that should be as soon as the lice appear in any numbers.

THE WHITE CABBAGE BUTTERFLY.

(*Pieris rapæ*, Linn.)

The larva of this insect is emphatically the "Cabbage Worm" of growers. Inquiry among growers shows that many have been for some time using fresh air-slaked lime with very satisfactory results. The testimony is uniform in its favor where it has been tried, but all emphasize the fact that it must be *fresh*, must be finely sifted, and applied in the morning while the plants are damp. This is a cheap and most easily applied remedy, and it deserves a fair trial at the hands of all who are troubled with this insect. The dry hydrate, made as directed in an early part of this report, is even better than air-slaked lime.

The pyrethrum remedy, as recommended in Bulletin 50, has also proved effective in the hands of the few that have used it.

MISCELLANEOUS NOTES.

ELM-LEAF BEETLE.

This insect is still spreading in every direction, but was not, in New Brunswick, as injurious as in 1889. It did not appear until May 7th, fully three weeks later than in 1889, and then not in such numbers. The enormous quantity developed last year was largely destroyed by a fungous disease, and only a comparatively small remnant survived. The large trees on the campus I did not consider it necessary to spray at all. A row of small trees along the avenue to the seminary was sprayed only once with London purple, when it was noted that the larvæ were doing some damage. This checked them at once, and there was no further trouble. The developing beetles appeared in July, and after the beginning of August were seen no

more. Late in August, while repairs were being made in the belfry of the college building, one of the workmen brought me a box of the beetles, and stated that "the whole place is crowded with them." They were then already in winter quarters, and again I made absolutely certain that there is only a single annual brood. That this is normal, is shown by the fact that the beetles made no attempt at copulation, but went into winter quarters in midsummer. The idea of two or more broods arises thus: The beetles are first seen eating small holes; this is one brood. Later, the damage done by the larvæ is seen in the withering of the trees, and this is the second brood. The trees make an effort to put out new shoots, and these are riddled by the newly emerging beetles, the third brood.

CURCULIO NOTES.

No systematic experiments with this pest were made, as the principal work done at some of the Western stations is in this direction. I noted, however, early in spring, at Jamesburg, the peculiar crescent marks of the species on the June or service berry (*Amelanchier canadensis*), then about half grown. By beating, I got several specimens of the insect. I could not find eggs in the punctures, but found a large number of berries infested by a coleopterous larva, which I did not succeed in bringing to maturity. I have little doubt but that this plant will serve to sustain the species.

One experiment I made which is rather instructive. I noticed a large number of apples last year with crescents that had been outgrown, and no trace of larval work. This season I gathered a lot of fallen apples and a lot of fallen plums, all with the crescent mark, and put them into separate jars on moist earth. At the same time I gathered from some convenient branches a number of freshly stung apples, leaving others as freshly stung, and marking them. These picked apples were put into other jars, part on moist earth, part in one entirely dry and open. A number of apples with older punctures were also gathered and put on moist earth. The marked branches were examined at intervals and selected apples cut into over the punctures. In no case did I find a larva to develop on an apple remaining on the tree. In two or three instances only had the egg hatched at all, and the larva began to eat. In no case did the eaten channel exceed an eighth of an inch, and this would have been out-

grown. Of the plucked apples, those with old punctures on moist soil developed only a very few larvæ, which fed on the decaying parts of the apple. In the case of the apples with fresh punctures in the dry jars, these shriveled and matured no larvæ, though several hatched. In the case of those placed in moist soil, they began to decay after a little, and I believe that from nearly every puncture a mature larva was obtained. I found nine full-grown larva in an apple no larger than a half-grown plum, and there were anywhere from three to six in each, in the decaying mass. In the case of the plums they became soft at once, and, I believe, developed every egg deposited.

These experiments prove, I think, that curculio punctures will not cause the dropping of apples, and indeed this has never been claimed. They prove, further, that, though the eggs may hatch, the larvæ will not develop in growing apples. They prove, too, that a decaying condition is necessary to bring them to maturity, and that they will not develop in withered fruit where no decay is started.

The result is important, because it emphasizes the necessity of clearing the orchards of fallen fruit, and especially early in the season. If, as I believe, the curculio larva does not develop in growing apples, the stings on the fruit are disfiguring merely. If the fallen fruit is persistently gathered and destroyed or fed to stock, scarcely a single beetle should come to maturity in an apple orchard! On pears I have not experimented, but should expect the result to be as with the apples.

At the risk of getting tiresome I must repeat—KEEP YOUR ORCHARDS CLEAR OF FALLEN FRUIT.

THE APPLE BORER.

This insect is very destructive to young apple trees in many parts of the State, and is even more injurious to quince. It seems almost impossible to get quince trees into bearing, in some localities. Cutting is unsatisfactory, as the larvæ penetrate deep into the solid wood, where they are practically out of reach.

There is only one thing to be done, and that is, give the trunks of the trees a protective covering that will prevent the deposit of eggs. The beetle flies as early as May 20th and lasts until the middle of July, and during that time the trunk must be kept coated with poi-

soned whitewash, as recommended for the peach borer, and the branches at the forks might also be so treated. As a substitute for whitewash, soft soap, with carbolic acid added, has been used in some cases, and is said to be effective. Persistently spraying the trunk with strong whale-oil soapsuds has also been practiced successfully.

c

Figure 26.

Apple borer: *a*, Larva; *b*, Pupa; *c*, Beetle.

Of all these, I consider the poisoned whitewash as best. It will do no good where the borers are already in the trunk. It is a preventive, not a cure, and must be in place when the insects arrive. The borers live at least two years as larvæ, and do not remain long in the pupa state. The beetles fly during midday, and it goes without saying that they should be picked off and killed whenever noticed.

THE ARMY WORM.

In some localities this insect has shown itself in injurious numbers during the past season. It has usually started in heavy growth, out of the "muck heaps," as one farmer put it, and thence has made its typical marches.

The eggs are laid, as shown in Figure 27, by the female moth, who makes her appearance quite early in spring. They are laid in such numbers that the larvæ, Figure 28, soon run themselves out of fodder and wander off for more. If the army is large, the march can be checked with difficulty only, if at all. In such cases, a broad ditch with steep sides should be cut, and on the infested side they should be supplied with fresh food, thoroughly poisoned. All those getting into the ditch should be killed by paddles. All food in their

road should be poisoned, so as to thin the host as it marches. If a good lookout be kept, and they be noticed when they are beginning their work, thoroughly poisoning the food all round will often stop them. Or they may be sprayed with the kerosene emulsion and killed in that way. It is bad policy to attempt to save too much

Figure 27.

Leucania unipuncta: Showing eggs on grass; pupa and moth.

Figure 28.

Army worm.

when these insects are beginning to spread. Mow a wide swath all around the spot, if at all confined, and then destroy everything within the inclosed space by fire, by rolling with a heavy roller or in any other way that is effective. The larva goes under ground to pupate, and in midsummer hatches into a moth, very few days thereafter, giving rise to a second brood of caterpillars.

In this latitude, my observations indicate, the winter is passed partly in the pupa and partly in the moth stage. Old stubble or grain stacks are favorite places of oviposition in spring, and it illustrates the importance of clean culture, of laying entirely bare, each fall, the ground that is not in grass or winter grain. It has been thought that this insect was at its worst after a dry season, followed by a wet spring. The conditions this year were the reverse. Last season was abnormally wet, while this spring, in some places where the insects did most damage, there was no rain for three weeks.

THE CORN WORM.

Corn has suffered unusually this year, from the attacks of this pest. In watching a corn-husking in Cumberland county, fully seventy-five per cent. of the ears were seen to be injured by the larvæ. The injured spaces were, more or less, mildewed, and anywhere from one-fourth to one-half the ear was valueless. In Union county the injury was reported slight by some, moderate by others; but as a whole the more northern counties escaped with comparatively little damage, while the southern counties suffered severely.

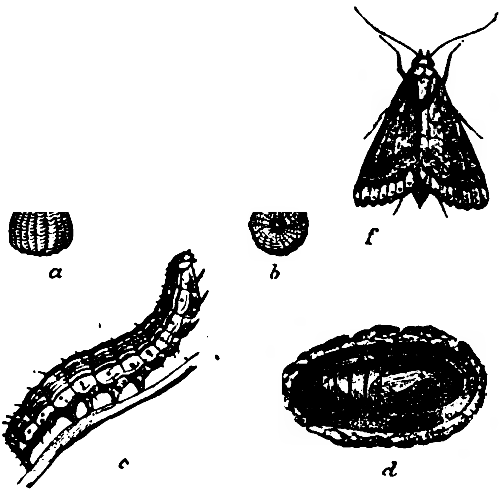

Figure 29.

Heliothis armiger: a, Egg, from side; b, Same, from top—both enlarged; c, Larva—corn worm; d, Pupa; e, Moth, with wings expanded; f, Same, wings folded.

The figure (29) will show the appearance of the insect in its different stages. I can find evidence of only two broods during the season. The first brood prefers early sweet corn, and it was unusual to get early ears without some signs of injury. In many cases, where the ears were small, the entire top was eaten off, husks, silk and all. The second brood, however, does most damage. It appears just about the time "roasting ears" are getting into condition for market, and any-

where from one to six young larvæ from one-quarter to one-half an inch in length were found in the ears on sale at New Brunswick in early August.

Peas were considerably damaged by the first brood, pods being eaten into and the peas devoured. The larvæ were nearly full grown as the peas were in best condition for market, and considerable damage was done. I failed to recognize the larva at first, owing to the fact that it was of a uniform green color, without any traces of the ordinary markings. The resulting moth, however, was typical in all respects. Tomatoes were, this year, more than usually injured, the larva eating into the fruit, as shown in Figure 30, and sometimes even boring into the stem.

Figure 30.

Corn worm attacking tomato.

When full grown, the worms leave their food-plant and change to a pupa under ground. The larvæ of the first brood go just beneath the surface, where they form a flimsy silken cocoon in an oval cell, transforming to moths in about two weeks thereafter. None of the larvæ bred by me went deep into the earth of the breeding-jar, but pupated just below the surface; some, indeed, scooping out the cell only to the required depth, and covering themselves with a thin web intermixed with grains of sand and bits of chaff.

The second brood, which passes the winter in the pupa state, digs deeper into the soil, and forms a more perfect cell in which to spend the winter.

REMEDIES.

The most effective means of lessening damage from these pests, is fall plowing of infested ground. Experiments made by others have proved that where the pupa-cells are broken and the inclosed pupa brought into direct contact with the surrounding earth, wet and cold will destroy it. Cornfields are often left after cutting, until the following spring. This gives an opportunity for nearly all the pupa to pass the winter successfully, and even if the field be plowed early in spring, the larger proportion would not suffer much, even if the cells are broken up.

NEMATODE ATTACK ON OATS.

Soon after the wheat aphids had appeared in force, and oats were well up, complaints were made that the latter were being killed, and that they were suffering worse than wheat. I was not examining oat fields at this time, and accepted the statements that the lice were doing the injury, until complaints came from regions where I knew the lice to be not numerous. Then examination showed that though there were some lice in oat fields, they were not in sufficient numbers to account for the sickly and devitalized condition of the fields. Examining a bunch of roots, the trouble was seen to rest here. There were no swellings or galls, no borings, no traces of eating or puncturing; but the rootlets were shriveled, devitalized and small. I concluded that this could not be insect work, and handed the specimens to Dr. Halsted for study as to the presence of fungi. None were found that could be charged with this result; but Dr. Halsted did find a number of cysts, which were probably those of a nematode worm. No living examples were found, and we concluded that the attack was over for the year, and so answered correspondents. A note in the Crop Bulletin of the State Weather Service called attention to this probability, and suggested stimulating applications where the oats were worth saving. Many fields were plowed under, but where the stand was healthy and the soil good, the plants recovered, and made a fair crop, though in all cases, I believe, decidedly below the average.

This attack on oats extended throughout the State, covering thus a greater area than the wheat-louse invasion, and, I have been informed, did considerable damage in the Province of Ontario, Canada.

Had the nature of the attack been sooner recognized, some study of the worm might have been made; but everything was attributed to the wheat louse this season, until it was too late to do more than exonerate this latter pest.

REMEDIES.

The only suggestion to be made under this head at present is the application of stimulants to the soil. This is to force the plant and enable it to endure the injury during the attack and to recover rapidly thereafter. I would suggest the potash salts in connection with more special fertilizers, on the chance that they might have a direct destructive effect on the worms. It is perhaps well to say that the worms are very minute and not readily visible to the naked eye.

THE CLOVER-LEAF BEETLE.

One of the most remarkable illustrations of a natural check to what promised to be a serious attack on clover came to my notice this spring.

On April 28th, Mr. W. W. Case, of Baptisttown, wrote concerning a caterpillar which had appeared in great numbers in his clover fields. In response to a request for specimens, he wrote May 1st, stating: "They seem to extend over a large section, and appearances are that they may become destructive. Much clover shows plain marks of their ravages. Are worst in old sod fields and pasture fields containing much white clover. Found round the tips of grass in early morning and in foul weather. In some places almost as plentiful as dew-drops."

The specimens when they reached me were dead, evidently killed by a fungus with which they were filled. I had not then noticed Dr. Lintner's paper in his fifth report, and it was impossible to make out anything from the specimens. Another supply was written for, and on May 6th Mr. Case writes: "I cannot understand why none of the specimens arrived alive, as all were alive and *very* lively when sent—in fact, I could hardly keep them in the box long enough to close the lid. They seem to be on the increase, and are all over sod fields in countless numbers." The second lot of specimens reached me in equally bad condition, and I suggested alcoholic specimens, a few of which, killed in 50 per cent. alcohol, Mr. Case sent me; but

even these were made almost unrecognizable by the fungus development, which had been but imperfectly checked by the weak alcohol.

On May 21st, Mr. Case wrote: "Since writing my last the pest has entirely disappeared. So entirely, that having sent you all my specimens, have been unable to obtain more."

May 5th, Mr. B. F. Page, of Newport, N. J., wrote that his clover was being destroyed by an entirely new pest, of which he forwarded samples. The specimens were in the same condition as those received from Mr. Case—not one alive.

May 6th, Mr. James Borrup, Netherwood, N. J., writes: "I hereby send specimens of insects by which my clover field is completely overrun. I can count a dozen to the square foot, and they seem to be doing much damage, eating the leaves."

The specimens reached me in the same diseased condition, and not one alive.

May 8th, Mr. George W. Hockenbury, Locktown, N. J., sent me a lot of "specimens of worms taken from grass fields. Some are alive, while others are dead and partly dried up. They have been very plentiful for the past week, but are fast decreasing in numbers."

At this time the New York papers began to publish items of worms in grass fields, collected by the bushel, all evidently referring to this same pest; but though I wrote to the persons mentioned, I obtained no answer, nor were my letters returned.

On May 5th, while investigating the wheat louse at Westville, I noticed that the clover seemed eaten, and found a few living and many dead specimens of what I now recognized as the larva of the clover-leaf beetle. I tried getting the living larvæ, most of them small, back to New Brunswick; but all were dead within three hours after being collected.

May 6th, noticed the clover affected at Vineland, found a few dead, but no living specimens of this same larva.

May 12th, the same appearance was noted at Freehold, and during these early days of May I also found several fields near New Brunswick in which there were many dried-up larvæ and traces of their injuries.

The largest living larvæ seen at Westville were less than half an inch in length, cylindrical, with fine transverse wrinkles or folds. The general color was green, the head yellowish, and a whitish stripe on the back or dorsum. They were found on the under side of clover

leaves, eating irregular holes, and dropped to the ground readily when disturbed, in accordance with their well-known habit. Very few living specimens were found, but coiled on the blades of grass, near the tips, dozens could be seen; some still soft and flabby, some dried up until all that was left was a dark collar around the grass blade.

In the report for 1889, pages 282, 283, this insect is figured in all its stages, and I then ventured the prediction that "there is every probability that it will appear in some parts of the State during the season of 1890, as an injurious insect."

This prediction was verified and nullified to a remarkable extent. It appeared in injurious numbers in every direction; but the remarkable epidemic disease, caused by a parasitic fungus, *Empusa sphærosperma*, checked the danger completely, and nothing more was heard of it. However, on the sea-shore, at Long Branch, during the latter part of July or early in August, there were thousands of the beetles crawling and flying about, and, unless another epidemic intervenes, danger threatens next year. The insects feed principally at night, especially where the larvæ are more than half grown, and during the day lie coiled up at the base of the plant.

REMEDIES.

If injury by this pest should be noted next season, a dressing of kainit should be applied, preferably before or during a rain, and afterward fresh air-slaked lime should be scattered broadcast over the field, so as to get both leaf and soil covered as far as possible.

A large number of other species were brought to notice during the summer; but these were of less importance than those treated of in this report, and their further study was necessarily deferred until another season.

APPENDIX TO THE REPORT OF THE ENTOMOLOGIST.

In view of the importance of a full knowledge of the chemical composition of some of our most commonly-used insecticides, I requested Prof. E. B. Voorhees, Chemist of the Station, to make analysis of the arsenites and of "X. O. Dust," furnishing him samples purchased from a local dealer and presumably an average material. Mr. Gillette's results in avoiding injury to foliage from London purple, by adding lime, suggested experiments of a chemical nature to discover exactly what combinations took place, and also what would be the best proportion of lime to use and the best manner of using it.

The following results were attained under the direction of Prof. Voorhees, and explain the matter perfectly.

As to the "X. O. Dust," its action on insects is so much more prompt and effectual than that of a pure ground tobacco, that I suspected some more active agent. The result leaves me as much as ever in the dark. There is not enough carbolic acid to add to the effect of the tobacco, and the mineral matter found does not seem to give the reason for its more intense action. The excellent mechanical condition of the substance undoubtedly adds to its effect, and possibly the variety of tobacco used may be also responsible.

CHEMICAL TESTS OF INSECTICIDES.

CHAS. S. CATHCART.

London purple, a refuse from the manufacture of analine dye, is composed of arsenic, calcium and small quantities of iron, aluminium and sulphuric acid, mixed with the dye refuse. The arsenic and calcium are the principal constituents, and are found in both the soluble and insoluble forms.

An analysis of a sample submitted by the Entomologist of the Station, gave:

	Per Cent.
Moisture	3.27
Arsenious oxide (As_2O_3)	41.44
Lime (CaO)	24.32
Iron and alumina ($Fe_2O_3 + Al_2O_3$)	3.37
Sulphuric acid (SO_3)	.31
Dye, by difference	27.29
	100.00

Since London purple is a waste product, its chemical composition is variable. This variation may consist in both the amount and combination of the arsenic compounds, the dye moisture, etc.

In Bulletin 18 of Cornell University, the Horticulturist stated that arsenic in London purple existed in the form of the normal calcium arsenite ($Ca_3 (As O_3)_2$), and that over 50 per cent. of it was quickly soluble in water. His remarks were based upon an analysis made at the Cornell Station.

The value of London purple as an insecticide is considerably reduced by the presence of an appreciable amount of arsenic which is soluble in water. This study was made for the purpose of determining the form of the arsenic in the commercial article and the best method for rendering it insoluble.

Storer states the solubility of arsenious oxide and the three arsenites of calcium as follows:

$As_2 O_3$, arsenious oxide. Very slowly soluble in cold but more quickly soluble in boiling water.

$Ca (As O_2)_2$, mono-calcium arsenite. Somewhat soluble in water.

$Ca_2 As_2 O_5$, di-calcium arsenite. Sparingly soluble in water.

$Ca_3 (As O_3)_2$, tri-calcium or normal arsenite. Soluble in aqueous solutions of arsenious acid.

Arsenic in the form of normal calcium arsenite ($Ca_3 (As O_3)_2$) is not soluble in water.

EXPERIMENT I.

A sample of London purple was digested forty hours with water, at the temperature of the room, and the solution yielded, upon analysis—

	Per Cent.
Arsenious oxide ($As_2 O_3$)	8.11
Lime ($Ca O$)	2.85

EXPERIMENT II.

Another portion was digested with hot water until all the soluble arsenic was dissolved. This solution contained—

	Per Cent.
Arsenious oxide ($As_2 O_3$)	16.45
Lime ($Ca O$)	3.26

The amounts of the constituents found in either of these experiments do not correspond to those required to satisfy the formula of the normal calcium arsenite ($Ca_3 (As O_3)_2$). The solution in I. contained only about one-half as much arsenic as the solution in II., while the difference in the percentages of lime is not great. From these facts it seems that the arsenic exists partly as an arsenite of calcium, which is soluble in water, and arsenious oxide, which, as stated above, is sparingly soluble in cold but readily in hot water. The presence of a larger amount of lime in the solution of Experiment II. can then be accounted for, since normal calcium arsenite ($Ca_3 (As O_3)_2$) is soluble in aqueous solutions of arsenious acid, which is formed when arsenious oxide is dissolved.

The percentages of insoluble arsenic and calcium (total less the soluble), satisfy the formula of the normal calcium arsenite ($Ca_3 (As O_3)_2$).

London purple is valuable as an insecticide, but its use has been somewhat restricted on account of the injury it does to the foliage by burning. It has been proved that leaves burned in this manner contain arsenic in their texture, which is obtained from the soluble arsenic.

Mr. C. P. Gillette, of the Iowa Station, in Bulletin 10 says that by the addition of milk of lime, London purple can be safely used in moderate strengths upon the tenderest foliage, but he does not state the reason for it.

The manufacture of this dye requires the use of large quantities of arsenic. The dye being extracted leaves the arsenic mixed with the refuse matter. The refuse matter is then digested with milk of lime, to render the arsenic insoluble, but for some reason, whether intentionally or not, the object is not accomplished, since it always contains some soluble arsenic.

In order to ascertain to what extent the arsenic could be made insoluble, fresh lime was slaked and thoroughly mixed with water, thus forming milk of lime. This was preserved in an air-tight bottle, since lime in contact with the carbonic acid present in the air forms a carbonate of lime, which does not contain the required properties found in lime alone. The milk of lime, after determining the percentage of lime, was added to the purple in different amounts. The mixtures were then allowed to digest, filtered and the solutions tested for arsenic.

It was found that if the London purple was to be used immediately, it would require more lime to produce the desired effect than if the mixture was allowed to digest a few hours, as is shown in the following.

EXPERIMENT III.

Milk of lime containing 13.25 per cent. of lime was digested with the purple one hour, and the filtrate contained .94 per cent. of arsenious oxide ($As_2 O_3$), but when the same mixture was allowed to stand three or four hours, the filtrate contained no arsenic. The filtrate from the mixture containing 17.70 per cent. of lime was tested after digesting one hour, but contained no arsenic.

As was to be expected, on account of the greater solubility of arsenious oxide, the warm-water solution required more lime than the preceding one. Arsenic was found in all solutions until 22 per cent. of lime had been added.

It is safe to say that the arsenic can be easily made insoluble by the addition of milk of lime, but the exact amount required will depend upon the sample.

Assuming that this is an average sample, and that all of the arsenic exists in the soluble form, it would require 35.16 per cent. of lime to form the normal calcium arsenite ($Ca_3 (As O_3)_2$). Our experiments show, however, that it requires an excess of lime to produce this result—that is, it required 22 per cent. of lime to change that which we found soluble to the insoluble form. In this proportion it would take about 72 per cent. of lime for the 41.44 per cent. of arsenious oxide. Since lime is used as an insecticide, the addition of this large excess will not at least produce any injurious effects.

We would recommend for ordinary use that a mixture in the proportion of one pound of London purple to three-fourths of a pound of fresh lime, be thoroughly mixed in one gallon of hot water, and allowed to digest about two hours. If the water can be conveniently kept hot during the entire time it would be advisable to do it. Water can then be added in sufficient quantities to bring it to the desired strength.

PARIS GREEN.

There are two compounds sold under the name of Paris green. The first is also known as Sheele's green, and is prepared by dissolv-

ing one part white arsenic and two parts of commercial potash in thirty-five parts of boiling water. This is added to a solution of copper sulphate as long as a precipitate, consisting of an arsenite of copper, is formed.

The second form is known as Vienna or Schweinfurth's green. It is prepared by dissolving white arsenic in boiling water and adding it to a solution of verdigris; or, by dissolving fifty parts of copper sulphate and ten parts of lime in twenty gallons of good vinegar. To this solution is added a hot solution of white arsenic. The precipitate in either of these methods is an aceto-arsenite of copper.

This sample contained—

	Per Cent
Moisture	.74
Arsenious oxide (As_2O_3)	68.82
Copper oxide (CuO)	30.59
	100.15

It is generally stated that Paris green contains no arsenic which is soluble in water, but on testing the solution, which had been digesting two hours, it was found to contain—

Arsenious oxide (As_2O_3) .40 per cent.

This small quantity can be readily rendered insoluble by the addition of a little lime when mixing.

ARSENIOUS OXIDE.

According to the experiments of Mr. Gillette, the addition of lime to arsenious oxide, or white arsenic, as it is called, produces the opposite effect to that obtained by adding lime to London purple. Since the soluble arsenic in each case exists in the same form, there should be no difference in the results obtained by the addition of sufficient quantities of lime.

The object of this study was for the purpose of determining whether the addition of lime to arsenious oxide would form an insoluble arsenite.

Arsenious oxide is sparingly soluble in cold, but quite readily in hot water. For this reason two experiments were made, the first in the hot-water solution, and the other in the solution obtained by digesting at the temperature of the room.

EXPERIMENT I.

Arsenious oxide ($As_2 O_3$) requires 84.85 per cent. of lime to form the insoluble or normal calcium arsenite ($Ca_3 (As O_3)_2$), but our experiments on London purple show that in order to obtain this result a large excess of lime must be used. A mixture of one part, by weight, of arsenious oxide and one and five-tenths parts of lime was boiled twenty minutes. The filtrate was tested, and contained no arsenic.

EXPERIMENT II.

Arsenious oxide and lime were mixed in various proportions, and allowed to digest at the temperature of the room for two hours. As the quantity of lime was increased the arsenic found in the filtrate decreased, until the filtrate from the mixture of one part, by weight, of arsenious oxide and one and one-tenth parts of lime contained no arsenic.

These experiments prove that by the addition of lime, in the proportion of one part, by weight, of arsenious oxide to one and five-tenths parts of lime, all the soluble arsenic, whether obtained by dissolving the arsenious oxide completely or by digesting it in cold water, can be made insoluble. When this is done, there will be less injury to the foliage than when the arsenious oxide is used alone.

X. O. DUST.

X. O. Dust consists of a mixture of finely-ground sand, lime and tobacco, to which has been added a small amount of carbolic acid. An analysis gave:

	Per Cent.
Moisture	6.98
Organic and volatile matters	53 69
Mineral matter	39.33
	100.00

The organic and volatile matters contain 3.40 per cent. of carbonic acid and a trace of carbolic acid.

The mineral matter contains:

	Per Cent.
Insoluble residue (sand)	14.96
Iron and alumina ($Fe_2O_3 + Al_2O_3$)	2.47
Lime (CaO)	17.10
Magnesia (MgO)	2.09
Phosphoric acid (P_2O_5)	.40
Potash (K_2O)	2.58
	39.60

APPENDIX.

APPENDIX.

ACT OF INCORPORATION.

The New Jersey Agricultural Experiment Station was established by authority of the following acts of the Legislature of the State:

CHAPTER CVI.

An Act to provide for the establishment of an Agricultural Experiment Station.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey*, That for the benefit of practical and scientific agriculture, and for the development of our unimproved lands, the New Jersey Agricultural Experiment Station, with suitable branches, is hereby established.

2. *And be it enacted*, That the direction and management of this institution shall be committed to a Board of Directors, which shall consist of the Governor of the State, the Board of Visitors of the State Agricultural College, together with the President and the Professor of Agriculture of that institution.

3. *And be it enacted*, That the members of this Board shall be called together by the Secretary of the Board of Visitors, and shall organize by the election of a President and Secretary, who shall hold their offices for one year and until their successors are elected; five members shall constitute a quorum.

4. *And be it enacted*, That the Board of Directors shall hold a meeting each year at Trenton, on the third Tuesday in January, and other meetings at the call of the President, at such times and places as may best promote the objects of the institution.

5. *And be it enacted*, That the Board of Directors shall locate said Experiment Station and branches, and shall appoint a Director, who

shall have the general management and oversight of the experiments and investigations necessary to carry out the objects of said institution, and shall employ competent chemists and other assistants necessary to analyze soils, fertilizers and objects of agricultural interest, so as to properly carry on the work of the Station, and it shall make an annual report of its work to the Governor of the State.

6. *And be it enacted*, That a sum not exceeding five thousand dollars in any one year is hereby appropriated to said New Jersey Experiment Station, which money shall be paid out from the State Treasury on the presentation of the bills of said Station, properly certified by the President and Secretary of the Board of Directors.

7. *And be it enacted*, That this act shall take effect immediately.

Approved March 10th, 1880.

CHAPTER LXXXI.

A Supplement to the act entitled "An act to provide for the establishment of an Agricultural Experiment Station," approved March tenth, one thousand eight hundred and eighty.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey*, That from and after the passage of this act, the Board of Directors mentioned and created by said act shall be called and known as the Board of Managers.

2. *And be it enacted*, That in addition to the powers now conferred upon said Board, they shall have power to elect a Treasurer, who shall hold his office for one year and until his successor shall be elected and qualified; and to appoint such other officers and agents as may be necessary to carry on the business of the institution; and to make such rules, by-laws and regulations for the government of the Board, and for carrying out the objects, business and purposes of the institution, as may, in their judgment, be necessary and proper.

3. *And be it enacted*, That the annual appropriation for the support of the New Jersey Agricultural Experiment Station be and the same is hereby increased from its present sum of five thousand dollars a year to eight thousand dollars a year.

4. *And be it enacted*, That this act shall take effect immediately.

Approved March 9th, 1881.

CHAPTER CCVIII.

A Supplement to the supplement to an act entitled "An act to provide for the establishment of an Agricultural Experiment Station," approved March ninth, one thousand eight hundred and eighty-one.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey,* That section three of the supplement to the act entitled "An act to provide for the establishment of an Agricultural Experiment Station," be amended so as to read as follows:

3. *And be it enacted,* That the expenses of said Station, when presented to the Comptroller of the State, accompanied by the proper vouchers, duly certified by the President and Secretary of the Board of Directors, shall, upon warrant of said Comptroller, be paid out of the State Treasury; *provided,* such expenses do not exceed the sum of eleven thousand dollars in any year.

2. *And be it enacted,* That this act shall take effect immediately.

Approved May 9th, 1884.

CHAPTER CCCVII.

An Act to provide for the construction of a State Laboratory for the State Agricultural Experiment Station.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey,* That the sum of thirty thousand dollars be and hereby is appropriated for the construction of a State Laboratory for the use of the State Agricultural Experiment Station, under the direction of the Board of Managers of the State Agricultural Experiment Station, on land selected by the said Board of Managers; *provided,* such land shall be acquired without cost or expense to the State of New Jersey; which sum the Treasurer of this State is hereby authorized to pay for such purpose to the Treasurer of said State Agricultural Experiment Station, upon the warrant of the Comptroller, as bills therefor shall be presented, marked approved by the President and two members of the said Board of Managers of said State Agricultural Experiment Station.

2. *And be it enacted*, That the Chemist or Chemists of the State Agricultural Experiment Station shall analyze all samples of milk, butter or other farm products, or the imitations thereof, that may be sent to said Station by the State Dairy Commissioner and his assistants and agents, and shall report to the said Commissioner the results of such analyses, and the costs thereof shall be paid out of the appropriation made to said Station.

3. *And be it enacted*, That this act shall take effect immediately.

Approved April 23d, 1888.

An Act to prevent the spread of fungous diseases of plants.

WHEREAS, The officers of the State Agricultural Experiment Station have discovered certain new fungous growths that threaten serious injury to important agricultural interests of the State; therefore,

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey*, That when the officers of the State Agricultural Experiment Station shall discover any new fungous growth which is doing injury to plants or vines, and while the same is confined to limited areas, they are hereby authorized and empowered to enter upon any lands bearing vines or plants so affected, and destroy the same by fire or otherwise, as they shall deem best.

2. *And be it enacted*, That any damage to private property resulting from the operation of destroying the said fungous growth by the officers of the State shall be certified to by them, and the amount of damage paid to the owners thereof from the same fund and in the same manner as is paid to owners of diseased animals killed by order of the State Board of Health.

3. *And be it enacted*, That expenditures under this act shall not exceed one thousand dollars in any one year.

4. *And be it enacted*, That this act shall take effect immediately.

Approved May 23d, 1890.

An Act to establish a Weather Service in New Jersey, and to provide for the appointment of a Board of Directors and President thereof, and appropriating money to pay the actual expenses of the same.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey,* That the establishment of a Weather Service being necessary to secure a complete history of the weather of New Jersey, in order to furnish trustworthy material for study of its climate, to acquaint the people of the State with the physical conditions of every locality, based upon reliable climatic data, and during the growing season to furnish reliable information as to the actual condition of the staple crops, thereby greatly benefiting the agricultural, commercial and municipal interests, there is hereby created at the Agricultural Experiment Station, New Brunswick, a Central Weather Station.

2. *And be it enacted,* That the Director, the Senior Chemist, the Professor of Botany and Horticulture, and a fourth person, to be appointed by the Governor, shall constitute a Board of Directors, and be duly qualified as like officers of the State.

3. *And be it enacted,* That the Director of the State Experiment Station is hereby appointed President of the Board, who, by and with the advice of the Directors, shall establish, if practicable, one volunteer Weather Station in each county of the State, and furnish the same with a set of standard instruments, instrument shelter, rain and snow gauge, and that said Director shall supervise the same; he shall receive reports therefrom and reduce the same to tabular form, and report the same monthly for publication as the New Jersey Weather Report, and shall annually make a report to the Governor, which shall contain a detailed statement of all expenditures made during the year and a summary of the observations taken at the various Stations.

4. *And be it enacted,* That the President of the Board shall print, under contract, copies of each monthly report, and such weekly reports during the growing season as may be deemed advisable, the same to be distributed by the Board.

5. *And be it enacted,* That there is hereby appropriated for the establishment of said Weather Stations the sum of one thousand dollars, or so much thereof as may be necessary for the purpose of meeting the actual expenses of carrying out the provisions of this

act; no part of said sum shall be paid for salaries of any officer or for office rent.

6. *And be it enacted*, That no money shall be expended except under the order of the President-Director, by and with the approval of the Board.

7. *And be it enacted*, That this act shall take effect immediately.

Approved June 19th, 1890.

LAWS OF NEW JERSEY.

An Act to regulate the manufacture and sale of fertilizers.

1. That every commercial fertilizer which shall be offered for sale in this State shall be accompanied by an analysis, stating the percentage therein of ammonia, or its equivalent of nitrogen; of potash, in any form or combination soluble in distilled water, and of phosphoric acid in any form or combination; the portion of phosphoric acid soluble in distilled water; that portion soluble in a neutral solution of citrate of ammonia at a temperature not exceeding one hundred degrees Fahrenheit; and that portion of phosphoric acid not soluble in either of the above-named fluids, shall each be determined separately; and the material from which the phosphoric acid is obtained shall also be stated; a legible statement of such analysis shall accompany all packages or lots of over one hundred pounds, sold, offered or exposed for sale.

2. That the Chemist of the State Board of Agriculture shall be the Inspector of Fertilizers; it shall be his duty to analyze one or more samples of every kind of commercial fertilizers coming within the provisions of this act, which may be offered for sale within the State, and of which he shall be informed.

3. That manufacturers, dealers, and all persons interested, may obtain an analysis by notifying the Chemist of the State Board of Agriculture, upon which notification he shall be authorized to analyze, at his discretion, samples selected by himself, and to furnish certified copies of such analysis to the persons on whose application they were made; and it shall also be his duty to report all such analyses to the State Board of Agriculture.

4. That the Chemist of the State Board of Agriculture shall receive for each certificate of analysis made by him, a sum not to exceed fifteen dollars, to be paid by the person or persons applying therefor.

5. That any person selling, offering or exposing for sale any commercial fertilizer without the analysis required by the first section of this act, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense.

Approved March 24th, 1874.

SUPPLEMENT.

SEC. 1. That the penalty or penalties prescribed in section five of that act may be sued for and recovered, in an action of debt, in any court of competent jurisdiction in this State, in the name of any person who will sue for the same, one-half thereof for his own use, and the other half to be paid to the County Superintendent of Public Schools of the county in which such suit or suits shall be brought, for the use of the public schools in their county.

Approved March 31st, 1875.

CHAPTER CXIX.

A Supplement to an act entitled "An act to regulate the manufacture and sale of fertilizers," approved March twenty-fourth, one thousand eight hundred and seventy-four.

1. BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey,* That the fifth section of the act to which this act is a supplement, which section now reads as follows:

"5. *And be it enacted,* That any person selling, offering or exposing for sale any commercial fertilizer without an analysis required by the first section of this act, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense," be and the same is hereby amended so as to read as follows:

5. *And be it enacted,* That any person selling, offering or exposing for sale any commercial fertilizer without an analysis required by

the first section of this act, or the act to which this act is a supplement, or with an analysis stating that the fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense; *provided further*, that the provisions of this section, or the act to which this act is a supplement, shall not apply to any manure sold at a price not exceeding one-half a cent per pound, nor to any imported guanos.

2. *And be it enacted*, That this act shall take effect immediately.

Approved March 27th, 1878.

A Supplement to an act entitled "An act to provide for the construction of a State Laboratory for the State Agricultural Experiment Station," approved April 23d, 1888.

1. Be it enacted *by the Senate and General Assembly of the State of New Jersey*, That the further sum of eight thousand and eight hundred dollars be and hereby is appropriated for the purpose of paying the costs and expenses necessarily incurred in the construction and completion of the State Laboratory for the use of the State Agricultural Experiment Station, which sum of eight thousand and eight hundred dollars shall be paid by the Treasurer of the State, upon the warrant of the Comptroller, to the Treasurer of the said New Jersey Agricultural Experiment Station.

2. *And be it enacted*, That this act shall take effect immediately.

Approved April 17th, 1891.

CATALOGUE OF BULLETINS

ISSUED BY THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION FROM ITS ORGANIZATION IN 1880 TO DECEMBER 31ST, 1890.

1.	May 17, 1880.	Suggestions in Regard to the Cranberry Rot and its Cure.
2.	June 4, 1880.	Raspberry Disease and Suggestions for Overcoming it.
3.	June 25, 1880.	Analyses of Land Plaster.
4.	July 3, 1880.	Analyses of Guanos, Superphosphates and Special Manures.
5.	Aug. 9, 1880.	Analyses of Bone Dust.
6.	Aug. 16, 1880.	Analyses of Various Fertilizers.
7.	Aug. 28, 1880.	Analyses of Various Fertilizers.
8.	Sept. 6, 1880.	Analyses of Various Fertilizers.
9.	Oct. 16, 1880.	Analyses of Various Fertilizers.
10.	Jan. 15, 1881.	Rational System of Feeding Milch Cows.
11.	March 7, 1881.	Ensilage.
12.	March 30, 1881.	Valuation of Fertilizers.
13.	May 5, 1881.	Land Plaster and Ground Bone.
14.	May 26, 1881.	Clover-Seed Midge.
15.	July 18, 1881.	Commercial Fertilizers; their Composition and Valuations.
16.	Sept. 20, 1881.	Commercial Fertilizers.
17.	Nov. 12, 1881.	Commercial Fertilizers.
18.	Dec. 20, 1881.	Sorghum Sugar Cane.
19.	Feb. 20, 1882.	Green Fodder Corn; Dried Fodder Corn; Ensilage.
20.	March 30, 1882.	Valuation of Fertilizers.
21.	July 10, 1882.	Chemical Fertilizers (Incomplete).

22. July	28, 1882.	Commercial Fertilizers (Complete and Incomplete).
23. Oct.	10, 1882.	Commercial Fertilizers.
24. Nov.	25, 1882.	Sorghum; Feeding Experiments with Sorghum Seed.
25. Dec.	8, 1882.	Sorghum and Sugar; Experiments and Investigations of 1882.
26. Jan.	4, 1883.	Field Experiments.
27. April	21, 1883.	Prices of Nitrogen, Phosphoric Acid and Potash, and Analyses of Incomplete Fertilizers.
28. July	2, 1883.	Analyses and Valuations of Complete Manures and Special Fertilizers.
29. Aug.	2, 1883.	Analyses and Valuations of Nitrogenous Superphosphates, Ground Bones, Plain Superphosphates, Poudrettes and Miscellaneous Fertilizers.
30. Nov.	16, 1883.	Results of Field and Laboratory Experiments with Sorghum, for the Season of 1883.
31. Dec.	22, 1883.	Nitrate of Soda, or Chili Saltpeter, as a Top Dressing for Wheat.
32. March	28, 1884.	Prices of Nitrogen, Phosphoric Acid and Potash.
33. Aug.	2, 1884.	Analyses and Valuations of Complete Fertilizers.
34. Sept.	27, 1884.	Analyses and Valuations of Incomplete Fertilizers.
35. July	1, 1885.	Meaning of Stations' Valuations, Schedule of Trade Values for 1885, Chemical Composition, Retail Prices and Guaranteed Analyses of Fertilizer Supplies.
36. Oct.	2, 1885.	Analyses and Valuations of Complete Fertilizers.
37. Dec.	7, 1885.	Miscellaneous Fertilizers.
38. Dec.	21, 1885.	The Rio Grande Sorghum Sugar Works.
39. March	19, 1886.	Meaning of Stations' Valuations; Schedule of Trade Values for 1886.
40. Oct.	16, 1886.	Analyses and Valuations of Complete Fertilizers.

41. Jan. 22, 1887. The Extraction of Sugar from Sorghum, at Rio Grande, Cape May County, New Jersey.
42. Sept. 3, 1887. Analyses and Valuations of Complete Fertilizers.
43. Dec. 31, 1887. Analyses and Valuations of Complete Fertilizers, of Ground Bones and of Miscellaneous Material.
44. March 8, 1888. Sorghum and Sugar-Making; a Report upon Experiments made at Rio Grande during the Season of 1887.
45. March 10, 1888. Prices of Nitrogen, Phosphoric Acid and Potash.
46. May 23, 1888. Insect Pests and the Means for Destroying Them.
47. June 23, 1888. Analyses and Valuations of Incomplete Fertilizers.
48. Aug. 7, 1888. Analyses and Valuations of Complete Fertilizers.
49. Nov. 10, 1888. Analyses and Valuations of Complete Fertilizers, Ground Bone and Miscellaneous Samples of other Fertilizing Materials.
50. Dec. 5, 1888. Insects Injurious to the Cabbage and the Best Means of Preventing Their Ravages.
51. Dec. 31, 1888. Sorghum and Sugar-Making; a Report upon Experiments Made at Rio Grande during the Season of 1888.
52. March 20, 1889. What are the Worst Weeds of New Jersey?
53. March 26, 1889. Prices of Nitrogen, Phosphoric Acid and Potash.
54. March 27, 1889. Potash as a Fertilizer.
55. March 28, 1889. Entomological Suggestions and Inquiries.
56. July 15, 1889. Analyses and Valuations of Complete Fertilizers.
57. July 31, 1889. Experiments with Different Breeds of Dairy Cows.
58. Aug. 5, 1889. Analyses of Incomplete Fertilizers.
59. Sept. 23, 1889. Analyses and Valuations of Complete Fertilizers.

60. Oct.	30, 1889.	Ground Bones and Miscellaneous Samples.
61. Oct.	31, 1889.	Experiments with Different Breeds of Dairy Cows.
62. Nov.	6, 1889.	The Horn Fly.
63. Dec.	30, 1889.	Experiments on Tomatoes.
64. Dec.	31, 1889.	Some Fungous Diseases of the Cranberry.
65. Jan.	31, 1890.	Experiments with Different Breeds of Dairy Cows.
66. March	1, 1890.	Fertilizing Materials.
67. May	3, 1890.	Note on the Wheat Louse.
68. April	30, 1890.	Experiments with Different Breeds of Dairy Cows.
69. July	15, 1890.	Analyses and Valuations of Complete Fertilizers.
70. July	26, 1890.	Some Fungous Diseases of the Spinach.
71. Aug.	14, 1890.	Analyses of Incomplete Fertilizers; and the Value of Home Mixtures.
72. Oct.	4, 1890.	Plant Lice, and How to Deal with Them.
73. Oct.	6, 1890.	Analyses and Valuations of Complete Fertilizers.
74. Oct.	21, 1890.	Ground Bones and Miscellaneous Samples.
75. Nov.	7, 1890.	Insecticides, and How to Apply Them; Experiment Record for 1890.
76. Nov.	28, 1890.	Some Fungous Diseases of the Sweet Potato.
77. Dec.	11, 1890.	Experiments with Different Breeds of Dairy Cows.

CATALOGUE OF SPECIAL BULLETINS

ISSUED BY THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION FROM ITS ORGANIZATION IN 1880 TO DECEMBER 31ST, 1890.

A.	March	20, 1882.	Yellow Tobacco.
B.	April	15, 1887.	Alfalfa, or Lucerne.
C.	April	8, 1889.	Pollen *versus* Rain.
D.	April	9, 1889.	Memoranda about Cranberry Insects.
E.	April	13, 1889.	Oyster Interests of New Jersey.
F.	July	26, 1889.	The Horn Fly.
G.	Aug.	7, 1889.	The Potato Rot.
H.	Aug.	28, 1889.	The Cranberry Scald.
I.	Oct.	28, 1889.	Questions Relative to General Farm Practice.
J.	Nov.	30, 1889.	The Sweet Potato Rot.
K.	Feb.	28, 1890.	The Insects Injuriously Affecting Cranberries.
L.	April	22, 1890.	Observations upon the Peach for 1890.

FERTILIZERS.

FORM FOR DESCRIPTION OF SAMPLE.

In taking fair average samples, such as will justly represent the manufacturer as well as the consumer, it is very important that every precaution be taken, so that in case of a suit at law the person signing the description can testify to its accuracy. The writing should be plain and legible. The filled-out form, if wrapped with the sample, will serve as a label. If any printed circular, pamphlet, analysis or statement accompanies the fertilizer, or is used in its sale, send a copy with the specimen.

1. *Brand of Fertilizer*..

2. *Name and address of Manufacturer*..

....

....

3. *Name and address of Dealer from whose stock this sample is taken*........................

....

4. *Date of taking this sample*...

5. *Selling price per ton, hundred, bag or barrel*...

6. *Selling weight claimed for each package weighed*...

7. *Actual weights of packages opened*..

8. *Copy of analysis or composition affixed to packages of this Fertilizer*......................

....

....

....

....

9. *Signature*...

(To be signed in every case by the person taking sample.)

P. O. Address...

FODDERS AND FEEDS.

FORM FOR DESCRIPTION OF SAMPLE.

The person sending samples to the Station for analysis without charge, will be provided with a form like this for each sample, and must fill up every one of the blank particulars given, so as to make the description complete and definite, and in every case write his signature, as indorsing the accuracy of it. As there is much responsibility in taking fair average samples, such as will justly represent the manufacturer as well as the consumer, it is very important that every precaution be taken, so that in case of a suit at law the person signing the description can testify to its accuracy. The writing should be plain and legible. The filled-out form, if wrapped with the sample, will serve as a label. If any printed circular, pamphlet, analysis or statement accompanies the sample, or is used in its sale, send a copy with the specimen.

1. *Brand of Fodder or Feed*..

2. *Name and address of Manufacturer*...

....

3. *Name and address of Dealer from whose stock this sample is taken*.........................

....

4. *Date of taking this sample*..

5. *Selling price per ton, hundred, bag or barrel*..

6. *Selling weight claimed for each package weighed*..

7. *Actual weights of packages opened*..

8. *Copy of Analysis or composition affixed to packages of this sample*........................

....

....

....

9. *Signature of person taking sample*...

   P. O. Address..

DIRECTIONS TO BE FOLLOWED IN SAMPLING FERTILIZERS.

Inspectors may sample fertilizers found either—

1. Upon farms;
2. In dealers' storehouses; or
3. In manufactories.

The Station prefers that samples should be drawn either upon farms or in dealers' storehouses.

In sampling fertilizers found upon farms, Inspectors should ascertain—

1. That the samples are not taken from stock of a past season, or from stock which is or has been carelessly stored.
2. That they were received in good condition, and have since been so stored that a noticeable gain or loss of moisture has been prevented.

In sampling from *dealers' storehouses*, Inspectors should also ascertain whether the fertilizers are of old (last season's) or of new stock. Preference should always be given to the present season's goods. Circumstances may, however, make it advisable to sample old stock; in such cases, this fact must be distinctly stated by the Inspector in his report to the Station's Director.

If, for any reason, it is found to be necessary to draw samples at factories, Inspectors should decline—

1. To sample from piles of fertilizers.
2. To sample from bags which are not distinctly marked with the brand, the manufacturer's name and the guaranteed analysis.

If fertilizers are found stored in piles only, Inspectors should cause six or more bags to be filled from different portions of the piles; from these bags the samples may be drawn in the usual manner.

Whenever the mechanical condition will allow, samples should be drawn by means of the *sampling tube* furnished by the Station.

It is not desirable to sample lots of less than one-half ton of any one brand. In such small lots portions may be taken from each bag; in larger lots each fifth or tenth bag may be opened. The several portions representing the same brand should then be carefully mixed and a quart fruit jar filled, securely closed and marked with labels furnished by the Station.

As soon as a sample has been taken, and *invariably* before bags of another brand have been opened, the Inspector should carefully fill out the blank describing samples.

He should copy *from the bags*—

1. The brand.
2. The name of the manufacturer.
3. The guaranteed analysis.

Other information needed for the description must be got from the owner of the fertilizer.

Each sample bottle should be separately wrapped in heavy paper and packed for transportation in a wooden box, properly closed. This box should be forwarded by express, directed to

THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION,
New Brunswick, N. J.

ORDER OF STATION WORK.

The largest portion of the Station work is in the analysis of fertilizers, field experiments, feeding experiments, with analyses of foods, fodders, milk, etc. To do these branches of work well, continuous and steady attention must be given to each of them while it is in progress, and other business has to be laid aside for the time. To make this necessary order of work as little disappointing as possible for those who desire work at the Station, we publish this statement of the subjects upon which we propose to work at the different periods of the year:

Feeding Experiments	January and February.
Analyses of Fertilizers	March to September 15th.
Field Experiments	April and May.
Field Experiments	Sept. 15th to Nov. 30th.
Annual Report	December.

Miscellaneous work of various kinds may arise to interfere with the perfect regularity of this plan, but for accomplishing the largest amount of work it will be necessary to adhere as closely to it as possible.

THIRD ANNUAL REPORT

OF THE

NEW JERSEY STATE

Agricultural College Experiment Station,

For the Year ending June 30th,

1890.

THIRD ANNUAL REPORT

OF THE

New Jersey State

AGRICULTURAL COLLEGE EXPERIMENT STATION,

FOR THE YEAR ENDING JUNE 30th,

1890.

To his Excellency Leon Abbett, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2d, 1887, and with an act of the Legislature of this State, approved March 5th, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College, the third annual report of the operations of that department of the college which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

The organization and control of the Station were placed, by a resolution of the Trustees of the College, in the hands of an "Executive Committee on the Agricultural College Experiment Station," consisting of the following gentlemen:

Austin Scott, Ph.D., President of the College, Chairman.
Hon. George C. Ludlow, ex-Governor of New Jersey.
Hon. Henry Bookstaver, LL.D.
Henry R. Baldwin, M.D.
James Neilson, Esq.

The staff of the Station on June 30th, 1890, was as follows:

Merrill E. Gates, Ph.D., LL.D., Acting Director.
Horace B. Patton, Ph.D., Chemical Geologist and Investigator of Soils.

Julius Nelson, Ph.D., Biologist and Investigator of Food-Products of State.

Byron D. Halsted, Sc.D., Botanist and Horticulturist.

John B. Smith, Entomologist.

Peter T. Austen, Ph.D., F.C.S., Consulting Chemist.

Charles S. Cathcart, M.S., Assistant Chemist.

Benjamin C. Sears, A.M., Superintendent of College Farm.

Irving S. Upson, A.M., Disbursing Clerk and Librarian.

J. Lester Rightmire, Mailing Assistant.

John Thomas, Janitor and Laborer.

In the annual reports upon the work of the Station submitted in 1888 and in 1889, in order to make the annual report of the Station work agree in the time covered with the annual report of the State Station, details of work not only up to June 30th, but for the entire year to December 31st, were submitted. For the same reason the appended report of the Station work is made this year to December 31st, 1890.

But the "statement of receipts and expenditures," herewith submitted, covers the fiscal year provided for by the United States law, from July 1st, 1889, to June 30th, 1890.

Since the first of July, 1890, the material changes in the staff of the Station were occasioned by the resignation of the Acting Director, President Merrill E. Gates, Ph.D., LL.D., on October 1st; the resignation of Professor Horace B. Patton, Ph.D., Chemical Geologist and Investigator of Soils, on July 31st; the resignation of Professor Peter T. Austen, Ph.D., F.C.S., Consulting Chemist, on December 31st, and the resignation of John Thomas, Janitor and Laborer, on September 30th. On the first of October, the Board of Control appointed James Neilson, Esq., Acting Director.

He submits herewith the detailed report of the work of the Station.

Respectfully submitted,

AUSTIN SCOTT,
President.

THE TRUSTEES OF RUTGERS COLLEGE
FOR
THE NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION
IN ACCOUNT WITH
THE UNITED STATES APPROPRIATION.

1890. *Dr.*

To receipts from Treasurer of the United States, as per appropriation for year ending June 30th, 1890, under act of Congress approved March 2d, 1887 .... $15,000 00

Cr.

June 30.	By salaries	$8,830 00	
"	" labor	1,466 70	
"	" supplies	289 02	
"	" freight and expressage	68 33	
"	" postage and stationery	303 92	
"	" printing	938 21	
"	" library	612 53	
"	" tools, implements and machinery	72 22	
"	" scientific instruments	597 71	
"	" chemical apparatus and supplies	134 52	
"	" furniture		
"	" general fittings		
"	" fencing and drainage		
"	" live stock	500 00	
"	" traveling	436 84	
"	" incidental expenses		
"	" buildings	750 00	
		$15,000 00	$15,000 00

We the undersigned, duly appointed auditors for the corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of the New Jersey Agricultural College, for the fiscal year ending June 30th, 1890, that we have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving no unexpended balance to be accounted for in the fiscal year commencing July 1st, 1890.

JAMES NEILSON,
G. C. LUDLOW,
Auditing Committee.

I hereby certify that the foregoing statement or account, to which this is attached, is a true copy from the books of account of the institution named.

FREDK. FRELINGHUYSEN,
Treasurer Rutgers College.

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